May 6, 2009

DMS Notice
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Discard: 05/15/2009

Dear County Sealers:

You are invited to participate in a series of meetings at DMS headquarters, 6790 Florin Perkins Road Sacramento on Thursday May 14th.

- Water meter manufacturers and regulators — 8:00 am
- Service agency fund distribution — 1:00 pm – 2:00 pm
- Handbook 133 rewrite review — 2:00 pm – 4:30 pm

For those interested parties who are unable to attend we intend to set up a webinar connection and provide contact information. Please let Elizabeth Moreno know if and how you wish to participate; in person or through webinar. You can reach Elizabeth at (916) 229 3011 or EMoreno@cdfa.ca.gov.

The meeting with water meter manufacturers is to discuss their proposed changes to the test draft sizes and repeatability requirements. We will be sharing data on different test drafts and the effect on repeatability and meter accuracy.

For the service agency funds we will discuss the appropriate method of distribution, based on either net or gross cost of weights and measures activities.

The review of Handbook 133 is to develop appropriate changes to reflect USDA's adoption of the 4th Edition of the handbook and to improve guidance on moisture loss.

Attached are revisions proposed for the handbook to date. All revisions are shown in **bold face print** by **~~crossing out~~** information to be deleted and **underlining** information to be added. Additions proposed for the handbooks are designated as such and are shown in **bold face print**.

It was recommended that states distribute this document to interested parties within their state for comment. NIST is requesting that comments or concerns regarding the draft changes be submitted to Lisa Warfield lisa.warfield@nist.gov before June 1. All received comments will be available for review prior to the conference. Additional comments will be taken during the open hearings.

For additional information, review the L&R Committee report at http://ts.nist.gov/WeightsAndMeasures/Publications/upload/10-LR-09-Pub16-FINAL.doc

The MLWG will meet Sunday, July 12, 2009 at 2:45 pm at the Annual Meeting in San Antonio, Texas.

Thank you for your participation in this important process.

Edmund E. Williams

Edmund E. Williams, Director
Division of Measurement Standards

Appendix C

Handbook 133 Revisions

Chapter 1. General Information

1.1. Scope

Routine verification of the net contents of packages is an important part of any weights and measures program to facilitate value comparison and fair competition. Consumers have the right to expect packages to bear accurate net content information. Those manufacturers whose products are sold in such packages have the right to expect that their competitors will be required to adhere to the same **laws and regulations.** ~~**standards.**~~

The procedures in this handbook are recommended for use to verify the net quantity of contents of packages kept, offered, or exposed for sale, or sold by weight, measure (including volume, and dimensions), or count at any location (e.g., at the point-of-pack, in storage warehouses, retail stores, and wholesale outlets).

When and where to use package checking procedures?

An effective program will typically include testing at each of the following levels.

Point-of-pack

Testing packages at the "point-of-pack" has an immediate impact on the packaging process. Usually, a large number of packages of a single product are available for testing at one place. This allows the inspector to verify that the packer is following current good packaging practices. Inspection at the point-of-pack also provides the opportunity to educate the packer about the legal requirements that products must meet and may permit resolution of any net content issues or other problems that arise during the testing. Point-of-pack testing is not always possible because packing locations can be in other states or countries. Work with other state, county, and city jurisdictions to encourage point-of-pack inspection on products manufactured in their geographic jurisdictions. Point-of-pack inspections cannot entirely replace testing at wholesale or retail outlets, because point-of-pack inspections do not include imported products or the possible effects of product distribution and moisture loss. Point-of-pack inspections only examine the manufacturing process. Therefore, an effective testing program will also include testing at wholesale and retail outlets.

Wholesale

Testing packages at a distribution warehouse is an alternative to testing at the point-of-pack with respect to being able to test large quantities of and a variety of products. Wholesale testing is a very good way to monitor products imported from other countries and to follow up on products suspected of being underfilled based on consumer complaints or findings made during other inspections, including those done at retail outlets.

Retail

Testing packages at retail outlets evaluates the soundness of the manufacturing, distributing, and retailing processes of the widest variety of goods at a single location. It is an easily accessible, practical means for state, county and city jurisdictions to monitor packaging procedures and to detect present or potential problems. Generally, retail package testing is not conducive to checking large quantities of individual products of any single production lot. Therefore, follow-up inspections of a particular brand or lot code number at a number of retail and wholesale outlets, and ultimately at the point-of-pack are extremely important aspects in any package-checking scheme. After the evaluation of an inspection lot is completed, the jurisdiction should consider what, if any, further investigation or follow-up is warranted. At the point-of-sale, a large number of processes may affect the quality or quantity of the product. Therefore, there may be many reasons for any inspection lot being out of compliance. A shortage in weight or measure may result from mishandling the product in the store, or the retailer's failure to rotate stock. Shortages may also be caused through mishandling by a distributor, or failure of some part of the packaging process. Shortages may also be caused by moisture loss (desiccation) if the product is packaged in permeable media. Therefore, being able to determine the cause of an error in order to correct defects is more difficult when retail testing is used.

(Amended 2002)

What products can be tested?

Any commodity sold by weight, measure, or count may be tested. The product to be tested may be chosen in several ways. The decision may be based on different factors, such as (1) marketplace surveys (e.g., jurisdiction-wide surveys of all soft drinks or breads), (2) surveys based on sales volume, or (3) audit testing (see Section 1.3**.** "Sampling Plans") to cover as large a product variety as possible at food, farm, drug, hardware stores, or specialty outlets, discount and department stores. Follow-up of possible problems detected in audit testing or in review of past performance tends to concentrate inspection resources on particular commodity types, brand names, retail or wholesale locations, or even particular neighborhoods. The expected benefits for the public must be balanced against the cost of testing. Expensive products should be tested because of their cost per unit. However, inexpensive items should also be tested because the overall cost to individual purchasers may be considerable over an extended period. Store packaged items, which are usually perishable and not subject to other official monitoring, should be routinely tested because they are offered for sale where they are packed. Products on sale and special products produced for local consumption should not be overlooked because these items sell quickly in large amounts.

Regardless of where the test occurs, remember that it is the inspector's presence in the marketplace through routine unannounced testing that ensures equity and fair competition in the manufacturing and distribution process. Finally, always follow up on testing to ensure that the problems are corrected; otherwise, the initial testing may be ineffective.

1.2. Package Requirements

The net quantity of content statement must be "accurate," but reasonable variations are permitted. Variations in package contents may be a result of deviations in filling. The limits for acceptable variation are based on current good manufacturing practices in the weighing, measuring, and packaging process. The first requirement is that accuracy is applied to the average net contents of the packages in the lot. The second requirement is applied to negative errors in individual packages. These requirements apply simultaneously to the inspection of all lots of packages except as specified in "Exceptions to the Average and Individual Package Requirements" in this section.

Inspection Lot

An "inspection lot" (called a "lot" in this handbook) is defined as a collection of identically labeled (except for quantity or identity in the case of random packages) packages available for inspection at one time. The collection of packages will pass or fail as a whole based on the results of tests on a sample drawn from ~~**this collection**~~ **<u>the lot</u>**. This handbook describes procedures to determine if the packages in an "inspection lot" contain the declared net quantity of contents and if the individual packages variations are within acceptable limits.

Average Requirement

In general, the average net quantity of contents of packages in a lot must at least equal the net quantity of contents declared on the label. Plus or minus variations from the declared net weight, measure, or count are permitted when they are caused by unavoidable variations in weighing, measuring, or counting the contents of individual packages that occur in current good manufacturing practice. Such variations must not be permitted to the extent that the average of the quantities in the packages of a particular commodity or a lot of the commodity that is kept, offered, exposed for sale, or sold, is below the stated quantity. (See Section 3.7. "Pressed and Blown Glass Tumblers and Stemware" and Section 4.3. "Packages Labeled by Count of 50 Items or fewer" for exceptions to this requirement.)

Individual Package Requirement

The variation of individual package contents from the labeled quantity must not be "unreasonably large." In this handbook, packages that are underfilled by more than the Maximum Allowable Variation specified for the package are considered unreasonable errors. Unreasonable shortages are not generally permitted, even when overages in other packages in the same lot, shipment or delivery compensate for such shortage. This handbook does not specify limits of overfilling, which is usually controlled by the packer **for economic and other reasons.**

Maximum Allowable Variation

The limit of **the** "reasonable **minus** variation" for an individual package is called a "Maximum Allowable Variation" (MAV). An MAV is a deviation from the labeled weight, measure, or count of an individual package beyond which the deficiency is considered **an** unreasonable **error**. Each sampling plan limits the number of negative package errors permitted to be greater than the MAV.

Deviations Caused by Moisture Loss or Gain

Deviations from the net quantity of contents caused by the loss or gain of moisture from the package are permitted when they are caused by ordinary and customary exposure to conditions that normally occur in good distribution practice and that unavoidably result in change of weight or measure. According to regulations adopted by the U.S. Environmental Protection Agency, no moisture loss is recognized on pesticides. (See Code of Federal Regulations 40 CFR Part 156.10.)

Why do we allow for moisture loss or gain?

Some packaged products may lose or gain moisture and, therefore, lose or gain weight or volume after packaging. The amount of ~~lost~~ moisture **loss** depends upon the nature of the product, the packaging material, the length of time it is in distribution, environmental conditions, and other factors. Moisture loss may occur even when manufacturers follow good distribution practices. Loss of weight "due to exposure" may include solvent evaporation, not just loss of water. For loss or gain of moisture~~, **apply**~~ the moisture allowances **may be applied before or after the package errors are determined**.

To apply an allowance before determining package errors, adjust the Nominal Gross Weight (see Section 2.3. "Basic Test Procedure") – Determine Nominal Gross Weight and Package Errors for Tare Sample, so the package errors are increased by an amount equal to the moisture allowance.

This approach is used to account for moisture loss in both the average and individual package errors.

It is also permissible to apply the moisture allowances after individual package errors and average errors are determined. For example, a sample of a product that could be subject to moisture loss might fail because the average error is minus or the error in several of the sample packages are found to be unreasonable errors (i.e., the package error is greater than the Maximum Allowable Variation permitted for the package's labeled quantity). ~~**to both the maximum allowable variations permitted for individual packages and the average net quantity of contents before determining the conformance of a lot**~~ **You can apply an allowance after determining the errors by adding an amount equal to the moisture allowance so the adjusted average error and individual package errors provide for loss of moisture from the sample packages.**

This handbook provides "moisture allowances" for some meat and poultry products, flour, and dry pet food. (See Chapter 2, Table 2.3. "Moisture Allowances") These allowances are based on the premise that when the average net weight of a sample is found to be less than the labeled weight, but not by an amount that exceeds the allowable limit, either the lot is declared to be within the moisture allowance or more information must be collected before deciding lot compliance or noncompliance.

Test procedures for flour, some meat, and poultry are based on the concept of a "moisture allowance" also known as a "gray area" or "no decision" area. (See Section 2.3, "Basic Test Procedure– Calculations.") When the average net weight of a sample is found to be less than the labeled weight, but not more than the boundary of the "gray area," the lot is said to be in the "gray" or "no decision area." The gray area is not a tolerance. More information must be collected before lot compliance or noncompliance can be decided. Appropriate enforcement should be taken on packages found short weight and outside of the "moisture allowance" or "gray area."

(Amended 2002)

Exceptions to the Average and Individual Package Requirements

There is an exemption from the average requirement for packages labeled by count of 50 or fewer items. The reason for this exemption is that the package count does not follow a "normal" distribution even if the package is designed to hold the maximum count indicated by the label declaration (e.g., egg cartons and packages of chewing gum). Another exception permits an "allowable difference" in the capacity of glass tumblers and stemware because mold capacity doesn't follow a normal distribution.

1.3. Sampling Plans

This handbook contains two sampling plans to use to inspect packages: "Category A" and "Category B." Use the "Category B" Sampling Plans to test meat and poultry products at point-of-pack locations that are subject to U.S. Department of Agriculture Food Safety and Inspection Service (FSIS) requirements. When testing all other packages, use the "Category A" Sampling Plan.

Why is sampling used to test packages?

Inspections by weights and measures officials must provide the public with the greatest benefit at the lowest possible cost. Sampling reduces the time to inspect a lot of packages, so a greater number of items can be inspected. Net content inspection, using sampling plans for marketplace surveillance, protects consumers who cannot verify the net quantity of contents. This ensures fair trade practices and maintains a competitive marketplace. It also encourages manufacturers, distributors, and retailers to follow good manufacturing and distribution practices.

Why is the test acceptance criteria statistically corrected, and what are the confidence levels of the sampling plans?

Testing a "sample" of packages from a lot instead of every package is efficient, but the test results have a "sampling variability" that must be corrected before determining if the lot passes or fails. The "Category A" sampling plans give acceptable lots a 97 % or better probability of passing. An "acceptable" lot is defined as one in which the "average" net quantity of contents of the packages equals or exceeds the labeled quantity. The "Category B" sampling plans give acceptable lots at least a 50 % probability of passing. The sampling plans used in this handbook are statistically valid. That means the test acceptance criteria are statistically adjusted, so they are both valid and legally defensible. This handbook does not discuss the statistical basis, risk factors, or provide the operating characteristic curves for the sampling plans. For information on these subjects, see explanations on "acceptance sampling" in statistical reference books.

Why random samples?

A randomly selected sample is necessary to ensure statistical validity and reliable data. This is accomplished by using random numbers to determine which packages are chosen for inspection. Improper collection of sample packages can lead to bias and unreliable results.

May audit tests and other shortcuts be used to identify potentially violative lots?

Shortcuts may be used to speed the process of detecting possible net content violations. These audit procedures may include the following: using smaller sample sizes, spot checks using tare lists provided by manufacturers, selecting samples without collecting a random sample. These and other shortcuts allow spot checking of more products than is possible with the more structured techniques, but do not take the place of "Category A" or "Category B" testing.

Can audit tests and other shortcuts be used to take enforcement action?

No. Do not take enforcement action using audit test results.

If, after an audit test, there is suspicion that a lot of packages is not in compliance, use the appropriate "Category A" or "Category B" sampling plan to determine if the lot complies with the package requirements.

1.4. Other Regulatory Agencies Responsible for Package Regulations and Applicable Requirements

In the United States, several federal agencies issue regulations regarding package labeling and net contents. The U.S. Department of Agriculture regulates meat and poultry. The Food and Drug Administration (FDA) regulates food, drugs, cosmetic products, and medical devices under the Food, Drug, and Cosmetic Act (FDCA) and the Fair Packaging and Labeling Act (FPLA). The Federal Trade Commission (FTC) regulates most non-food consumer packaged products as part of the agency's responsibility under the FPLA. The Environmental Protection Agency (EPA) regulates pesticides. The Bureau of Alcohol, Tobacco, and Firearms (ATF) in the U.S. Department of the Treasury promulgates regulations for packaged tobacco and alcoholic beverages as part of its responsibility under the Federal Alcohol Administration Act.

Packaged goods produced for distribution and sale also come under the jurisdiction of state and local weights and measures agencies that adopt their own legal requirements for packaged goods. Federal statutes set requirements that pre-empt state and local regulations that are or may be less stringent or not identical to federal regulation depending on the federal law that authorizes the federal regulation. The application of Handbook 133 procedures occurs in the context of the concurrent jurisdiction among federal, state, and local authorities. Therefore, all agencies using this handbook should keep abreast of the revisions to federal agency regulations that may contain sampling or testing information not in the regulations at the time of publication of this handbook. See Appendix A, Table 1-1. "Agencies Responsible for Package Regulations and Applicable Requirements" for information on the responsible agencies for package regulations and the requirements of this handbook that must be used when testing products concurrently subject to pre-emptive federal regulations.

1.5. Assistance in Testing Operations

If the storage, display, or location of any lot of packages requires special equipment or an abnormal amount of labor for inspection, the owner or the operator of the business must supply the equipment and/or labor as required by the weights and measures official.

1.6. Health and Safety

This handbook cannot address all of the health and safety issues associated with its use. The inspector is responsible for determining the appropriate safety and health practices and procedures before starting an inspection (e.g., contact the establishment's health and safety official). Comply with all handling, health, and safety warnings on package labels and those contained in any associated material safety data sheets. The inspector must also comply with federal, state, or local health and safety laws or other appropriate requirements in effect at the time and location of the inspection. Contact your supervisor to obtain information regarding your agencies safety and health policies and to obtain appropriate safety equipment.

1.7. Good Measurement Practices

The procedures in this handbook are designed to be technically sound and represent good measurement practices. To assist in documenting tests, we have included "model" inspection report forms designed to record the information.

Traceability Requirements for Measurement Standards and Test Equipment

Each test procedure presented in this handbook includes a list of the equipment needed to perform the inspection. The scales and other measurement standards used (e.g., balances, mass standards, volumetric, and linear measures) to conduct any test must be traceable to the National Institute of Standards and Technology (NIST). Standards must be used in the manner in which they were designed and calibrated for use.

Certification Requirements for Standards and Test Equipment

All measurement standards and test equipment identified in this handbook or associated with the test procedures must be calibrated or standardized before initial use. This must be done according to the **calibration procedures and other instructions found on NIST's Laboratory Metrology and Calibration Procedures website at http:\\ts.nist.gov\WeightsAndMeasures\CalibrationProcedures.cfm** ~~in NIST Handbook 145, "Handbook for the Quality Assurance of Metrological Measurements,"~~ or **using** other recognized procedures (e.g., those adopted for use by a state weights and measures laboratory). After initial certification, the standards must be routinely recertified according to your agency's measurement assurance policies.

Chapter 2. Basic Test Procedure – Gravimetric Testing

2.1. Gravimetric Test Procedure for Checking the Net Contents of Packaged Goods

The gravimetric test method uses weight measurement to determine the net quantity of contents of packaged goods. This handbook includes general test methods to determine the net quantity of contents of packages labeled in terms of weight and special test methods for packages labeled in terms of fluid measure or count. Gravimetric testing is the preferred method of testing most products because it reduces destructive testing while maximizing inspection resources.

2.2. Measurement Standards and Test Equipment

What type of scale is required to perform the gravimetric test method?

Use a scale (for this handbook the term scale includes balances) that has at least 100 scale divisions. It must have a load-receiving element of sufficient size and capacity to hold the packages during weighing. It also requires a scale division no larger than $^1/_6$ of the Maximum Allowable Variation (MAV) for the package size being weighed. The MAV/6 requirement is crucial to ensure that the scale has adequate resolution to determine the net contents of the packages. Subsequent references to product test criteria agreeing within one scale division are based on scale divisions that are equal to or only slightly smaller than the MAV/6.

Example: The MAV for packages labeled 113 g (0.25 lb) is 7.2 g (0.016 lb)
(See Appendix A, Table 2.5. "Maximum Allowable Variations (MAVs) for Packages Labeled by Weight."**)**
MAV/6 is 1.2 g (0.002 lb). In this example, a 1 g (0.002 lb) scale division would be the largest unit of measure appropriate for weighing these packages.

How often should I verify the accuracy of a scale?

Verify the accuracy of a scale before each initial daily use, each use at a new location, or when there is any indication of abnormal equipment performance (e.g., erratic indications). Recheck the scale accuracy if it is found that the lot does not pass, so there can be confidence that the test equipment is not at fault.

Which accuracy requirements apply?

Scales used to check packages must meet the acceptance tolerances specified for their accuracy class in the current edition of NIST Handbook 44 (HB 44) "Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices." The tolerances for Class II and Class III digital scales are presented in HB 44, Section 2.20. "Scales."

Note: If the package checking scale is not marked with a "class" designation, use Table 2-1. "Class of Scale" to determine the applicable tolerance.

What considerations affect measurement accuracy?

Always use good weighing and measuring practices. For example, be sure to use weighing and measuring equipment according to the manufacturer's instructions and make sure the environment is suitable. Place scales and other measuring equipment (e.g., flasks and volumetric measures) on a rigid support and maintain them in a level condition if being level is a requirement to ensure accuracy.

In testing, which tolerances apply to the scale?

Do not use a scale if it has an error that exceeds the specified tolerance in any of the performance tests described in the following section.

1. Determine the total number of divisions (i.e., the minimum increment or graduation indicated by the scale) of the scale by dividing the scale's capacity by the minimum division.

   Example: A scale with a capacity of 5000 g and a minimum division of 0.1 g has 50 000 divisions.

2. From Table 2-1. "Class of Scale", determine the class of the scale using the minimum scale division and the total number of scale divisions.

   Example: On a scale with a minimum division of 0.1 g and 50 000 total scale divisions the appropriate class of scale is "II."

Note: If a scale is used where the number of scale divisions is between 5001 and 10 000 and the division size is 0.1 g or greater and is not marked with an accuracy Class II marking, Class III scale tolerances apply.

Table 2-1. Class of Scale

Value of Scale Division[1]	Minimum and Total Number of Divisions	Class of Scale
1 mg to 0.05 g	At least 100, but not more than 100 000	II
0.1 g or more	More than 5000, but not more than 100 000	II
0.1 g to 2 g 0.000 2 lb to 0.005 lb 0.005 oz to 0.125 oz	More than 100, but not more than 10 000	III
5 g or more 0.01 lb or more 0.25 oz or more	More than 500, but not more than 10 000	III

[1]On some scales, manufacturers designated and marked the scale with a verification division (e) for testing purposes (e = 1 g and d = 0.1 g). For scales marked Class II, the verification division is larger than the minimum displayed division. The minimum displayed division must be differentiated from the verification scale division by an auxiliary reading means such as a vernier, rider, or at least significant digit that is differentiated by size, shape, or color. Where the verification division is less than or equal to the minimum division, use the verification division instead of the minimum division. Where scales are made for use with mass standards (e.g., an equal arm balance without graduations on the indicator) the smallest mass standard used for the measurement is the minimum division.

3. Determine the tolerance from Table 2-2. "Acceptance Tolerances for Class of Scale based on Test Load in Divisions" in divisions appropriate for the test load and class of scale.

Example: Determine the number of divisions for any test load by dividing the value of the mass standard being applied by the minimum division indicated by the scale. For example, if the scale has a minimum division of 0.1 g and a 1500 g mass standard is applied, the test load is equal to 15 000 divisions (1500/0.1). On a Class II scale with a test load between 10 000 and 20 000 divisions, Table 2-2. “Acceptance Tolerances for Class of Scale based on Test Load in Divisions” indicates the tolerance is plus or minus one division.

Table 2-2. Acceptance Tolerances for Class of Scale based on Test Load in Divisions

Test Load in Divisions		**Tolerance**
Class II Scale	**Class III Scale**	
0 to 5000	0 to 500	Plus or Minus 0.5 Division
5001 to 20 000	501 to 2 000	Plus or Minus 1 Division
20 001 or more	2001 to 4000	Plus or Minus 1.5 Divisions
Not Applicable	4001 or more	Plus or Minus 2.5 Divisions

Which performance tests should be conducted to ensure the accuracy of a scale?

Use the following procedures to verify the scale. The following procedures, based on those required in NIST Handbook 44, have been modified to reduce the amount of time required for testing scales in field situations.

Increasing-Load Test

Use certified mass standards to conduct an “increasing-load test” with all test loads centered on the load-receiving element. Start the test with the device on zero and progress with increasing test loads to a “maximum test load” of at least 10 percent more than the gross weight of the packages to be tested. Use at least three different test loads of approximately equal value to test the device up to the “maximum test load.” Verify the accuracy of the device at each test load. Include the package tare weight as one of the test points.

Decreasing-Load Test

For all types of scales, other than one with a beam indicator or equal-arm balance, conduct a “decreasing-load test” with all test loads centered on the load-receiving element. Use the same test loads used in the “increasing-load test” of this section, and start at the “maximum test load.” Remove the test loads in the reverse order of the increasing-load test until all test loads are removed. Verify the accuracy of the scale at each test load.

Shift Test

Use a test load equal to one-~~half~~**third** of the “maximum test load” used for the “increasing-load test.” For bench scales (see Diagram 1. “**Bench Scales or Balance”)** ~~place~~**apply** the test load **as nearly as possible at the center of each quadrant of the load receiving element as shown in Diagram 1. “Bench Scale or Balance.”** ~~in the center of four separate quadrants, equidistant between the center and edge of the load-receiving element and~~ **For Equal Arm Balances** determine the accuracy in each quadrant ~~for~~ **(see Diagram 2.** “**Equal-Arm Balance)**.” For example, where the load-receiving element is a rectangular or circular shape, place the test load in the center of the area represented by the shaded boxes in the following diagrams.

Diagram 1. Bench Scales or Balance

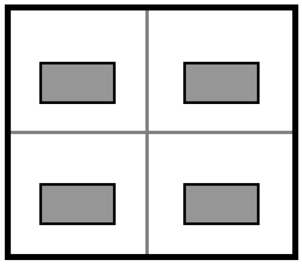
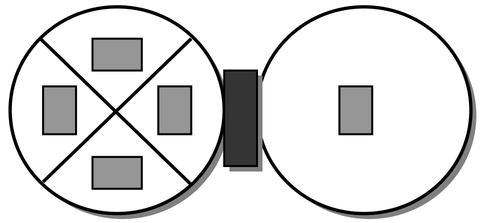


Diagram 2. Equal-Arm Balance



Return to Zero

Conduct the return to zero test whenever all the test weights from the scale are removed, check to ensure that it returns to a zero indication.

Which standards apply to other test equipment?

Specifications, tolerances, and other technical requirements for the other measurement standards and test equipment cited in this handbook are specified in the following NIST publications. These publications may be obtained from the Office of Weights and Measures or the U.S. Government Printing Office.

- Mass Standards – Use NIST Handbook 105-1, "Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures – Field Standard Weights (NIST Class F)" (1990)

- Volumetric Flasks and Cylinders – Use NIST Handbook 105-2, "Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures – Field Standard Measuring Flasks" (1996)

- Stopwatches – Use NIST Handbook 105-5, "Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures – Field Standard Stopwatches" (1997)

- Thermometers – Use NIST Handbook 105-6, "Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures – Specifications and Tolerances for Thermometers" (1997)

2.3. Basic Test Procedure

The following steps apply when gravimetrically testing any type of packaged product except Borax and glazed or frozen foods. If the tested products contain Borax, refer to Section 2.4, "Borax." If glazed or frozen food is tested, refer to Section 2.6. "Drained Weight for Glazed or Frozen Foods."

The Basic Test Procedure:

1. **Identify and define the inspection lot.**
2. **Select the sampling plan.**
3. **Select the random sample.**
4. **Measure the net contents of the packages in the sample.**
5. **Evaluate compliance with the Maximum Allowable Variation (MAV) requirement.**
6. **Evaluate compliance with the average requirement.**

Define the Inspection Lot

The official defines which packages are to be tested and the size of the inspection lot. The lot may be smaller or larger than the production lot defined by the packer. Only take action on the packages contained in the lot that has been defined.

Note: Normally, there will never be access to the entire “production lot” from a manufacturer. The “inspection lot” is selected from packages that are available for inspection/test at any location in the distribution chain.

> **Example:** An inspection lot should consist of all of the cans of a single brand of peach halves, labeled with a net quantity of 453 g (1 lb). When packages are tested in retail stores, it is not necessary to sort by lot code. If lot codes are mixed during retail testing, be sure to record the lot codes for all of the packages included in the sample so that the inspector and other interested parties can follow up on the information. For special reasons, such as a large number of packages or the prior history of problems with the product or store, the inspector may choose to define a lot as only one type of packaged product (e.g., ground beef). Another reason to narrowly define the lot is if the results of an audit test indicate the possibility of a shortage in one particular lot code within a particular product.

What is the difference between standard and random weight packages?

Standard packages are those with identical net content declarations such as containers of soda in 2 L bottles and 2.26 kg (5 lb) packages of flour. “Random packages” are those with differing or no fixed patterns of weight, such as packages of meat, poultry, fish, or cheese.

Sampling Plans

Where are sampling plans located for “Category A” inspections?

Use Appendix A, Table 2-1. “Sampling Plans for Category A,” to conduct “Category A” inspections.

Where are sampling plans located for “Category B” inspections?

Use Appendix A, Table 2-2. “Sampling Plans for Category B,” to conduct “Category B” inspections.

Basic Inspection Procedure and Record Keeping

How are the specific steps of the Basic Test Procedure documented?

Use an official inspection report to record the inspection information. Attach additional worksheets, test notes, and other information as needed. This handbook provides random and standard packaged products model inspection report forms in Appendix E, "Model Inspection Report Forms." Refer to Appendix E for sample instructions to the complete the forms box numbers. Modify the model reports and the box numbers to meet your agency's needs. Other formats that contain more or less information may be acceptable.

Note: Inspection reports should be legible and complete. Good recordkeeping practices typically include record retention for a specified period of time (e.g., 1 to 3 years).

- Record the product identity, packaging description, lot code, location of test, and other pertinent data.

- Record the labeled net quantity of contents in Box 1. Record both metric and inch-pound declarations if they are provided on the package label.

  Example: If the labeled weight is 453 g (1 lb), record this in Box 1.

- When the declaration of net quantity on the package includes both the International System of Units (SI) (metric) and inch-pound units, the larger of the two declarations must be verified. The rounding rules in NIST Handbook 130, "Uniform Packaging and Labeling Regulations" permit packers to round declarations up or down based on their knowledge of their package filling targets and the accuracy of packaging equipment.

  Determine the larger of the values by converting the SI declaration to inch-pound units, or vice versa, using conversion factors that are accurate to at least six places. Compare the values, and use the larger value in computing the nominal gross weight (see later steps). Indicate on the report which of the declarations are being verified when packages labeled with two units of measure are encountered.

  Example: If the net weight declared on a package is 1 lb, the metric equivalent (accurate to six significant digits) is 453.592 g. Do not round down or truncate values in the calculations until the nominal gross weight is determined and recorded. If the package is also labeled 454 g, then the metric declaration is larger than the inch-pound declaration and should be used to verify the net contents of the package. The Basic Test Procedure does not prohibit the use of units of weight instead of dimensionless units when recording package errors, nor does it prohibit the use of net content computer programs to determine product compliance. Record the unit of measure in box 2. The unit of measure is the minimum division of the unit of measurement used to conduct the test. If a scale is used that reads to thousandths of a pound, the unit of measure is 0.001 lb even if the scale division is 0.002 lb or 0.005 lb.

  Example: If the scale has a scale division of 0.5 g, the unit of measure is 0.1 g. If a weighed package that has an error of "- 0.5 g," record the error as "- 5" using "dimensionless units." If the scale indicates in increments of 0.002 lb, the unit of measure is 0.001 lb. If a weighed package has an error of "+0.016," record the error as "+ 16" using "dimensionless units." When using dimensionless units, multiply package errors by the unit of measure to obtain the package error in weight.

- Enter the appropriate MAV value in box 3 for the type of package (weight, volume, etc.), the labeled net contents, and the unit of measure.

Where are Maximum Allowable Variations found?

Find the MAV values for packages labeled by weight, volume, count, and measure in the tables listed below in Appendix A.

- packages labeled by weight — See Table 2-5.
- packages labeled by volume liquid or dry — See Table 2-6.
- packages labeled by count — See Table 2-7.
- packages labeled by length, (width), or area — See Table 2-8.
- packages bearing a USDA seal of inspection – Meat and Poultry — See Table 2-9.
- textiles, polyethylene sheeting and film, mulch and soil labeled by volume, packaged firewood, and packages labeled by count with less than 50 items — See Table 2-10.

How is the value of an MAV found?

Refer to the appropriate table of MAVs and locate the declared quantity that is on the package label in the column marked "Labeled Quantity." Read across the table to find the value in the column titled "Maximum Allowable Variation." Record this number in Box 3. Determine the MAV in dimensionless units and record in Box 4 on the Standard Package Report Form (a dimensionless unit is obtained by dividing the MAV recorded in Box 3 by the unit of measure recorded in Box 2). Refer to Appendix C. "Glossary," for the definition of dimensionless units.

How many MAVs are permitted in a sample?

To find out how many minus package errors are permitted to exceed the MAV, (refer to Appendix A) see Column 4 in either Table 2-1. "Sampling Plans for Category A" or Table 2-2. "Sampling Plans for Category B." Record this number in Box 8.

Random Sample Selection

How are sample packages selected?

Randomly select a sample from the inspection lot. Random number tables (see Appendix B. "Random Number Tables") or a calculator that is able to generate random numbers may be used to identify the sample. If the packages for the sample are not randomly selected, the test results may not be statistically valid.

Note: If the inspector and the party that is ultimately responsible for the packing and declaration of net weight for the product agree to an alternative method of sample selection, document how the sample packages were selected as part of the inspection record.

How is the size of the "Lot" determined?

Count the number of packages comprising the inspection lot or estimate the size to within 5 % and record the inspection lot size in Box 5.

How is the sample size determined?

Refer to Appendix A. Table 2-1. "Sampling Plans for Category A" or Table 2-2. "Sampling Plans for Category B" to determine the sample size. In Column 1, find the size of the inspection lot (the number recorded in Box 5 of the report form). Read across from Column 1 to find the appropriate sample size in Column 2 and record this number in Box 6 of the report form.

Tare Procedures

What types of tare may be used to determine the net weight of package goods?

This handbook defines three types of tare for the inspection of packaged goods. The tare weight may vary considerably from package to package as compared with the variability of the package net contents, even for packages in the same production lot. Although this is not common for most packaging, the basic test procedure in this handbook considers the variation for all tare materials.

Used Dry Tare

Used Dry Tare is defined as follows: Used tare material that has been air dried, or dried in some manner to simulate the unused tare weight. It includes all packaging materials that can be separated from the packaged product, either readily (e.g., by shaking) or by washing, scraping, ambient air drying, or other techniques involving more than "normal" household recovery procedures, but not including laboratory procedures like oven drying. Labels, wire closures, staples, prizes, decorations, and such are considered tare. Used Dry Tare is available regardless of where the packages are tested. The net content procedures described in this handbook reference Used Dry Tare.

Note: When testing frozen foods with the Used Dry Tare approach, the frost found inside frozen food packages is included as part of the net contents.

Unused Dry Tare

If testing packages in retail store locations where they are packaged, and sold in small quantities to the ultimate consumers, the basic test procedure may be modified by using samples of the packaging material available in the store. Unused dry tare is defined as:

All unused packaging materials (including glue, labels, ties, etc.) that contain or enclose a product. It includes prizes, gifts, coupons, or decorations that are not part of the product.

Wet Tare

Effective October 9, 2008, wet tare procedures must not be used to verify the labeled net weight of packages subject to regulation by the United States Department of Agriculture (USDA). The Food Safety and Inspection Service (FSIS) adopted specific sections of the 2005 4th Edition of NIST HB 133 by reference but not the "wet tare" method for determining net weight compliance. FSIS considers the free-flowing liquids in packages of meat and poultry products, including single-ingredient, raw poultry products, to be integral components of these products (see Federal Register, September 9, 2008 [Volume 73, Number 175] [Final Rule – pages 52189-52193]).

If the jurisdiction uses wet tare to determine net weight, follow the procedures described below that reference Used Dry Tare, except make no effort to dry the tare material. If Wet Tare is used to verify the net weight of packages ~~of fresh poultry, hot dogs, and franks that are subject to the USDA regulations~~, the inspector must allow for moisture loss. Wet Tare is defined as: Used tare material where no effort is made to dry the tare material. Free-flowing liquids are considered part of the tare weight.

How is a tare weight determined?

Except in the instance of applying unused dry tare, select the packages for the initial tare sample from the sample packages. Mark the first two (three or five) packages in the order the random numbers were selected; these packages provide the initial tare sample. Determine the gross weight of each package and record it in block a, "Gross Wt," under the headings "Pkg. 1," "Pkg. 2," "Pkg. 3," etc. on the report form. Except for aerosol or other pressurized packages, open the sample packages, empty, clean, and dry them as appropriate for the packaging material.

Does the inspection of aerosol containers require special procedures?

Yes, aerosol containers are handled differently for two reasons. First, regulations under the Uniform Packaging and Labeling Regulation in NIST HB 130 require that packages designed "to deliver" the product under pressure, "must state the net quantity of the contents that will be expelled when the instructions for use as shown on the container are followed." This means that any product retained in aerosol containers after full dispersion is included in the tare weight. Second, aerosol containers must not be opened because they are pressurized; for safety reasons they should not be punctured or opened. When emptying aerosol containers to determine a tare weight, exhaust them in a well-ventilated area (e.g., under an exhaust hood or outdoors) at least 15 m (50 ft) from any source of open flame or spark.

To ensure that the container properly dispenses the product, read and follow any dispensing instructions on the package. If shaking during use is specified in the instructions, periodically shake (at least two or three times during expulsion of the product). If directions are not given, shake the container five times with a brisk wrist twisting motion. If the container has a ball agitator, continue the shaking procedure for one minute after the ball has shaken loose.

How is the tare of vacuum-packed coffee determined?

The gross weight of a can of vacuum-packed coffee will be more after the seal is broken and air enters the can. In the procedure to determine the tare weight of the packaging material, correct the gross weight determined for unopened cans as follows. Use the initial tare sample packages, weigh, and record the gross weight of the product-filled cans before and after breaking the vacuum seal. Compute the average gross weight difference (open weight minus sealed weight) and record this in Box 13a of the report form. The nominal gross weight equals the average tare weight minus the average difference in gross weights plus the labeled weight (Box 14): Box 13 – Box 13a + Box 1.

How is it determined how many packages to select for the initial tare sample?

For the initial tare sample size, see Column 5 under initial tare sample size in Appendix A. Table 2-1. "Sampling Plans for Category A" or Column 3 under initial tare sample size in Appendix A, Table 2-2. "Sampling Plans for Category B." Record the initial tare sample size in Box 7 on the report form.

Note: The initial tare sample size is considered the total tare sample size when the sample size is less than 12.

How are the tare sample and <u>the</u> tare weight of the packaging material determined?

1. Except for unused dry tare at the point-of-pack, first determine the tare weight for each package in the initial tare sample and record the value in Row b, "Tare Wt." under the appropriate package number column.

2. For sample sizes of 12 or more, subtract the individual tare weights from the gross weights (Block a, minus Block b, on the report form) to obtain the net weight for each package and record these values in Block c, "Net Wt.," on the report form.

   Determine and record the "range of package errors" (called R_c) for the initial tare sample in Box 9 on the report form. (The range is the difference between the package errors.)

   (Amended 2002)

3. Determine and record the "range of tare weights" (called R_t) in Box 10.

4. Compute the ratio R_c/R_t by dividing the value in Box 9 by the value in Box 10. Record the resulting value in Box 11. (R_c and R_t must both be in the same unit of measure or both in dimensionless units.)

5. Determine and record in Box 12 the total number of packages to be opened for the tare determination from either **<u>Appendix A.</u>** Table 2-3. **<u>"Category A – Total Number of Packages to be Opened for</u>** or Table 2-4. **<u>"Determination – Number Include those Packages Opened for Initial Tare Sample."</u>**

   - In the first column (titled Ratio of R_c/R_t), locate the range in which the computed R_c/R_t falls. Then, read across to the column headed with the appropriate sample size.

   - If the total number of packages to open equals the number already opened go to step 6.

   - If the total number of packages to open is greater than the number of packages already opened, compute the number of additional packages to open for the tare determination and go to step 6. Enter the total number of tare samples in Box 12.

6. Determine the average tare weight using the tare weight values for all the packages opened and record the average tare weight in Box 13.

When and where is unused dry tare used, and how is it used to determine an average tare weight?

You may determine the average tare weight using samples of unused dry tare when testing meat, poultry, or any other products that are not subject to regulation of the Food and Drug Administration (FDA). You may use unused dry tare samples when conducting inspections at locations where the point-of-pack and sale are identical (e.g., store-packed products in a supermarket meat case). To determine unused dry tare at the point-of-sale, randomly select two (2) samples of unused dry tare, and weigh each separately. If there is no measurable variation in weight between the samples, proceed with the test using the weight of one of the samples. If the weight of the two (2) initial samples, randomly select three (3) additional tare samples and determine the average weight of all five (5) samples. Use this value as the average tare weight.

(Amended 2002)

Determine Nominal Gross Weight and Package Errors for Tare Sample

What is a nominal gross weight?

A nominal gross weight is used to simplify the calculation of package errors. To compute the nominal gross weight, add the average tare weight (recorded in Box 13) to the labeled weight (recorded in Box 1). To obtain the package error, subtract **<u>the nominal gross weight from each</u>** ~~**a**~~ package's gross weight~~.~~ ~~**from the nominal gross weight**~~. The nominal gross weight is represented by the formula:

Nominal gross weight = average tare + labeled weight

How are individual package errors determined for the tare sample packages?

Determine the errors of the packages opened for tare by subtracting the nominal gross weight recorded in Box 14 from the individual package gross weights recorded for each package (Pkg 1, Pkg 2, etc.) in Block a, "Gross Wt." The nominal gross weight must be used, rather than the actual net weight, for each package to determine the package error. This ensures that the same average tare weight is used to determine the error for every package in the sample, not just the unopened packages.

- For standard packages, record the package error in the appropriate plus or minus column on the report form for each package opened for tare.

- For random packages, determine the package error for the tare sample using a nominal gross weight for each package so that all of the package errors are determined with the same tare weight value. Record the package error on the Random Package Report Form in the appropriate plus or minus column under Package Errors.

  Note: Converting the package error to dimensionless units allows the inspector to record the package errors as whole numbers disregarding decimal points and zeroes in front and unit of measure after the number.

  Example: If weighing in 0.001 lb increments, the unit of measure is also 0.001 lb. If the package error for the first package opened for tare is +0.008 lb, instead of recording 0.008 lb in the plus column, record the error as "8" in the plus column. If the second package error is +0.060 lb, record the package error as "60" in the plus column, and so on. (This section does not prohibit the use of units of weight or computer programs instead of dimensionless units.)

How are individual package errors determined for the other packages in the sample?

Compare the gross weight of each of the unopened sample packages with the nominal gross weight (Box 14). Record the package errors in the "Package Errors" section of the report form using either units of weight (lb or g) or dimensionless units.

How is the total package error computed?

Add all the package errors for the packages in the sample. Be sure to subtract the minus package errors from the plus package errors and to record the total net error in Box 15.

Evaluating Results

How is it determined if a sample passes or fails?

The following steps lead the inspector through the process to determine if a sample passes or fails. If the product is subject to moisture allowance, follow the procedures under "Moisture Allowances" in this Chapter to correct the MAV.

How is it determined if packages exceed the Maximum Allowable Variation?

Compare each minus package error with the MAV recorded in Box 3 or Box 4 (if using dimensionless units). Circle the package errors that exceed the MAV. These are "unreasonable errors." Record the number of unreasonable minus errors found in the sample in Box 16.

How is it determined if the negative package errors in the sample exceed the number of MAVs allowed for the sample?

Compare the number in Box 16 with the number of unreasonable errors allowed (recorded in Box 8). If the number found exceeds the allowed number, the lot fails. Record in Box 17 whether the number of unreasonable errors found is less or more than allowed.

Note: If the total error recorded in Box 15 is a plus value and Box 17 is "No," then the number of unreasonable errors is equal to or less than the number allowed (recorded in Box 8) and the lot passes.

How is the average error of the sample determined and does the inspected lot pass or fail the average requirement?

Determine the average error by dividing the total error recorded in Box 15 by the sample size recorded in Box 6. Record the average error in Box 18 if using dimensionless units or in Box 19 if using units of weight. Compute the average error in terms of weight (if working in dimensionless units up to this time) by multiplying the average error in dimensionless units by the unit of measure and record the value in Box 19.

1. If the average error is positive, the inspection lot passes the average requirement.

2. If the average error is negative, the inspection lot fails under a "Category B" test. Record in Box 20.

3. If the average error is a negative value when testing under the Sampling Plans for "Category A," compute the Sample Error Limit (SEL) as follows:

   - Compute the Sample Standard Deviation and record it in Box 21.

   - Obtain the Sample Correction Factor from Column 3 of Appendix A. Table 2-1. "Sampling Plans for Category A" ~~test~~. Record this value in Box 22.

   - Compute the Sample Error Limit using the formula:

Sample Error Limit (Box 23) = Sample Standard Deviation (Box 21) x
Sample Correction Factor (Box 22)

4. Compliance Evaluation of the Average Error:

   - If the value of the Average Error (Box 18) is smaller than the SEL (Box 23), the inspection lot passes.

   - If the value of the Average Error (disregarding the sign) (Box 18) is larger than the SEL (Box 23) the inspection lot fails. However, if the product is subject to moisture loss, the lot does not necessarily fail. Follow the procedures under "Moisture Allowances" in this Chapter.

Moisture Allowances

How is reasonable moisture loss allowed?

If the product tested is subject to moisture loss, provide for the moisture allowance by following the steps listed below.

Determine the value of the moisture allowance if the product is listed below.

What are the moisture allowances for flour, ~~and~~ dry pet food <u>and other products</u>? (See Table 2.3. "Moisture Allowances.")

Table 2.3. Moisture Allowances		
If you are verifying the labeled net weight of packages of:	**The Moisture Allowance is:**	**Notes**
Flour	**3 %**	
Dry pet food	**3 %**	**Dry pet food means all extruded dog and cat foods and baked treats packaged in Kraft paper bags and/or cardboard boxes with a moisture content of 13 % or less at time of pack.**
Borax	**See Section 2.4.**	
Wet Tare Only		
If you are using Wet Tare in verifying the net weight of packages of one of the products listed below:	**The Moisture Allowance is:**	**Notice: Wet Tare must not be used in testing packages of meat and poultry subject to USDA regulations.**
Fresh poultry	**3 %**	**Fresh poultry is defined as poultry at a temperature of 3 °C (26 °F) that yields or gives when pushed with the thumb.**
Franks or hotdogs	**2.5 %**	
Bacon, fresh sausage, and luncheon meats	**0 %**	**For packages of bacon, fresh sausage, and luncheon meats, there is no moisture allowance if there is no free-flowing liquid or absorbent materials in contact with the product and the package is cleaned of clinging material. Luncheon meats are any cooked sausage product, loaves, jellied products, cured products, and any sliced sandwich-style meat. This does not include whole hams, briskets, roasts, turkeys, or chickens requiring further preparation to be made into ready-to-eat sliced product. When there is no free-flowing liquid inside the package and there are no absorbent materials in contact with the product, Wet Tare and Dried Used Tare are equivalent.**

~~**The moisture allowance for flour and dry pet food is 3 % of the labeled net weight.**~~

~~**Note: Dry pet food means all extruded dog and cat foods and baked treat products packaged in Kraft paper bags and/or cardboard boxes with a moisture content of 13 % or less at the time of**~~

~~**pack.**~~

What moisture allowance is used with Used Dry Tare when testing packages that bear a USDA Seal of Inspection?

There is no moisture allowance when inspecting meat and poultry from a USDA inspected plant when Used Dry Tare and a "Category A" sampling plan are used.

What moisture allowance is used with wet tare? ~~***when testing packages bearing a USDA seal of inspection?***~~

Effective October 9, 2008, wet tare procedures must not be used to verify the labeled net weight of packages subject to regulation by the United States Department of Agriculture. FSIS considers the free-flowing liquids in packages of meat and poultry products, including single-ingredient, raw poultry products, to be integral components of these products (see Federal Register, September 9, 2008 [Volume 73, Number 175] [Final Rule - pages 52189-52193])

See Table 2-3. "Moisture Allowances – Wet Tare Only."

- ~~**Use the following guideline when testing meat and poultry from any USDA inspected plant using Wet Tare and a Category A sampling plan.**~~

- ~~**For packages of fresh poultry that bear a USDA seal of inspection, the moisture allowance is**~~
- ~~**3 5 of the labeled net weight. For net weight determinations, only, fresh poultry is defined as poultry above –3 ºC (26 ºF). This is a product that yields or gives when pushed with the thumb.**~~

- ~~**For packages of franks or hotdogs that bear a USDA seal of inspection, the moisture allowance is 2.5 % of the labeled net weight.**~~

- ~~**For packages of bacon, fresh sausage, and luncheon meats that bear a USDA seal of inspection, there is no moisture allowance if there is no free-flowing liquid or absorbent materials in contact with the product and the package is cleaned of clinging material. Luncheon meats are any cooked sausage product, loaves, jellied products, cured products, and any sliced sandwich-style meat. This does not include whole hams, briskets, roasts, turkeys, or chickens requiring further preparation to be made into ready-to-eat sliced product. When there is no free-flowing liquid inside the package and there are no absorbent materials in contact with the product, Wet Tare and Dried Used Tare are equivalent.**~~

When there is free-flowing liquid or absorbent packaging materials in contact with the product, all free liquid is part of the wet tare.

Calculations

How is moisture allowance computed and applied ~~to the average error~~?

To compute moisture allowance, multiply the labeled quantity by the decimal percent value of the allowance.

> **Example:** Labeled net quantity of flour is 907 g (2 lb)
>
> Moisture Allowance is 3 % (0.03)
>
> Moisture Allowance = 907 g (2 lb) x 0.03 = 27 g (0.06 lb) record this value in Box 13a.

How is a Moisture Allowance made prior to determining package errors?

If the Moisture Allowance is known in advance (e.g., flour and dry pet food) it can be applied by adjusting the Nominal Gross Weight (NGW) used to determine the sample package errors. The Moisture Allowance (MA) in Box 13a is subtracted from the NGW. The NGW which is the sum of the Labeled Net Quantity of Contents (LNQC e.g., 907 g) and the Average Tare Weight from Box 13 (for this example use an ATW of 14 g (0.03 lb)) to obtain an Adjusted Nominal Gross Weight (ANGW) which is entered in Box 14.

The calculation is: LNQC 907 g (2 lb) + ATW 14 g (0.03 lb) = 921 g (2.03 lb) - MA 27 g (0.06 lb) = ANGW of 918 g (1.97 lb) which is entered in Box 14.

Package errors are determined by subtracting the ANGW from the Gross Weights of the Sample Packages (GWSP).

The calculation is: GWSP – ANGW = Package Error.

Note: When the NGW is adjusted by subtracting the Moisture Allowance value(s) the Maximum Allowable Variation(s) is not changed. This is because the errors that will be found in the sample packages have been adjusted by subtracting the Moisture Allowance (e.g., 3 %) from the NGW. That increases the individual package errors by the amount of the moisture allowance (e.g., 3 %). If the value(s) of the MAV(s) were also adjusted it would result in doubling the allowance.

How is a Moisture Allowance made after determining package errors?

You can make adjustments when the value of the Moisture Allowance is determined following the test (e.g., after the sample fails or if a packer provides a reasonable a moisture allowance based on data obtained using a scientific method) using the following approach:

If the sample failed the Average and/or the Individual Package Requirements both of the following steps are applied.

If the sample failed the Average Requirement but has no unreasonable package errors only step 1 is used. If the sample passes the Average Requirement but fails because the sample included one or more Unreasonable Package Errors (UPEs) only step 2 is used.

1. **Use the following approach to apply a Moisture Allowance to the sample after the test is completed. The Moisture Allowance (MA) is computed (e.g., 3 % x 907 g (2 lb) = 27 g (0.06 lb)**

and added to the Sample Error Limit (e.g., if the SEL is 0.023 add 0.06 to obtain an Adjusted SEL of 0.083). The ASEL (Adjusted Sample Error Limit) is then compared to the Average Error of the Sample and:

- **If the average error (disregarding sign) in Box 18 is smaller than the ASEL, the sample passes.**
- **If the average error (disregarding sign) in Box 18 is larger than the ASEL, the sample fails.**

2. If a Moisture Allowance is to be applied to the Maximum Allowable Variation(s), the following method is recommended:

The Moisture Allowance (MA) is computed (e.g., 3 % x 907 g (2 lb) = 27 g (0.06 lb) and added to the value of the Maximum Allowable Variation(s) for the labeled net quantity of the package (e.g., MAV for 907 g (2 lb) is 31.7 g (0.07 lb) + 27 g (0.06 lb) = AMAV of 58.7 g). Compare each minus package error to the AMAV. Mark package errors that exceed the AMAV and record the number of UPE's found in the sample. If this number exceeds the number of unreasonable errors allowed, the sample fails.

~~**How is the Maximum Allowable Variation corrected for the moisture allowance?**~~

- ~~**Adjust the MAV by adding the moisture allowance to the MAV.**~~

  ~~**Example: 907 g (2 lb) package of flour: moisture allowance added to the MAV = 31.7 g (0.07 lb) (MAV for 907 g [2 lb] package) + 27 g (0.06 lb) moisture allowance = a corrected MAV of 58.7 g (0.13 lb)**~~

- ~~**Correct MAV in dimensionless units by converting the moisture allowance to dimensionless units = 0.06 lb ÷ 0.001 lb = 60. Go to Box 4 and add the moisture allowance in dimensionless units to the MAV in dimensionless units.**~~

  ~~**Example: MAV = 70 (MAV for 2 lb where the unit of measure = 0.001 lb) + 60 (moisture allowance in dimensionless units) = 130. Minus package errors must exceed the MAV ± gray area before they are declared "unreasonable errors."**~~

- ~~**If the number of unreasonable errors exceeds the allowed number (recorded in Box 8), the inspection lot fails.**~~

~~**How is the average error for the moisture allowance corrected?**~~

~~**If the minus average error (Box 18) is larger (disregarding the sign) than the SEL (Box 23) and moisture loss applies, compare the difference between Box 18 and Box 23 with the moisture allowance recorded in Box 13a. (Make sure that all the values are in units of weight or in dimensionless units before making this comparison.) If Box 13a is larger than the difference between Box 18 and 23, then the lot is considered to be in the gray area.**~~

~~**Example: Box 13a for 2 lb flour is 60 (dimensionless units); Box 18 is 2 (dimensionless units); Box 23 is 0.550 (dimensionless units). The difference between Box 18 and Box 23 is 1.450 (dimensionless units). Since Box 13a is 60 (dimensionless units), Box 13a is larger than the difference between Box 18 and Box 23, the lot is**~~

~~**considered to be in the gray area and further investigation is necessary before ruling out moisture loss as the reason for shortweight.**~~

<u>What should you do when a sample is in the gray area?</u>

When the average error of a lot of fresh poultry, franks, or hot dogs ~~**from a USDA-inspected plant**~~ is minus, but does not exceed the established "moisture allowance" or "gray area," contact the ~~**appropriate USDA official and/or**~~ **<u>packer or</u>** plant management personnel to determine what information is available on the lot in question. Questions to the ~~**USDA official and/or**~~ **plant management representative** may include:

(a) Is a quality control program in place?
(b) What information is available concerning the lot in question?
(c) If net weight checks were completed, what were the results of those checks?
(d) What adjustments, if any, were made to the target weight?

Note: If ~~**USDA or**~~ the plant management has data on the lot, such data may help to substantiate that the "lot" **<u>had</u>** met **<u>the</u>** net content requirements at the point of manufacture.

This handbook provides "moisture allowances" for some meat and poultry products, flour, and dry pet food. These allowances are based on the premise that when the average net weight of a sample is found to be less than the labeled weight, but not by an amount that exceeds the allowable limit, either the lot is declared to be within the moisture allowance or further investigation can be conducted.

Deviations from net quantity of contents caused by the loss or gain of moisture from the package are permitted when caused by ordinary and customary exposure to conditions that occur under good distribution practices. If evidence is obtained and documented to prove that the lot was shipped from the packaging plant in a short-weight condition or was distributed under inappropriate or damaging distribution practices, appropriate enforcement action should be taken.
(Amended 2002)

2.4. Borax

How is it determined if the net weight labeled on packages of borax is accurate?

Use the following procedures to determine if packages of borax are labeled correctly. This procedure applies to packages of powdered or granular products consisting predominantly (more than 50 %) of borax. Such commodities are labeled by weight, but borax can lose more than 23 % of its weight due to moisture loss. However, it does not lose volume upon moisture loss, and this property makes possible a method of volume testing based on a density determination in the event that the net weight of the product does not meet the average or individual package requirements. This method may be used for audit testing to identify possible short-filling by weight at point-of-pack. Since the density of these commodities can vary at point-of-pack, further investigation is required to determine whether, such short filling has occurred.

Test Equipment

- Metal density cup with a capacity of 550.6 mL or (1 dry pt).

- Metal density funnel with slide-gate and stand.

- Scale or balance having a scale division not larger than 1 g or (0.002 lb).
- Rigid straightedge or ruler
- Pan suitable for holding overflow of density cup

Test Procedure

Follow Section 2.3. "Basic Test Procedures – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following test procedure to determine product compliance.

1. If the lot does not comply by weight with the sampling plan requirements (either the average or individual package requirements), select the lightest package and record the net weight of this package.

2. Determine the weight of the density cup.

3. Place the density cup in the pan and put the funnel on top of the density cup. Close the funnel slide-gate.

4. Pour sufficient commodity into the funnel so that the density cup can be filled to overflowing.

5. Quickly remove the slide-gate from the funnel, allowing the commodity to flow into the density cup.

6. Carefully, without agitating the density cup, remove the funnel and level off the commodity with the ruler or straight edge. Hold the ruler or straight edge at a right angle to the rim of the cup, and carefully draw it back across the top of the density cup to leave an even surface.

7. Weigh the filled density cup. Subtract the weight of the density cup from the gross weight of the commodity plus the density cup to obtain the net weight of commodity in the cup.

How is the volume determined?

1. Multiply the net weight (in pounds) as found for the package under test by 550.6.

2. Divide the answer just obtained by the weight of the commodity in the density cup, step 7. The result is the net volume of commodity in the package in milliliters.

3. Compare the net volume of the commodity in the package with the volume declared on the package. The volume declaration **must not** ~~is not located~~ **appear** on the principal display panel. **Instead, it will appear on the back or side of the package and may appear as:** ~~**The following example is how the declaration of volume should appear.**~~

Volume ____ cm^3 per NIST
Handbook 133

Note: (1 mL = 1 cm^3)

What action can be taken based on the results of the density test?

If the net volume of commodity in the lightest package equals or exceeds the declared volume on the package, treat the lot as being in compliance based on volume and take no further action. If the net volume of borax in the lightest package is less than the declared volume on the package, further compliance testing will be necessary. Take further steps to determine if the lot was in compliance with net weight requirements at point-of-pack or was short-filled by weight. To determine this, perform a laboratory moisture loss analysis to ascertain the weight of the original borax product when it was fully hydrated; obtain additional data at the location of the packager; and/or investigate the problem with the packager of the commodity.

2.5. The Determination of Drained Weight

Since the weight per unit volume of a drained product is of the same order of magnitude as that of the packaging liquid that is drained off, an "average nominal gross weight" cannot be used in checking packages of this type. The entire sample must be opened. The procedure is based upon a test method accepted by the U.S. Food and Drug Administration.

A tare sample is not needed because all the packages in the sample will be opened and measured.

The weight of the container plus drained-away liquid is determined. This weight is then subtracted from the gross weight to determine the package error.

Equipment

- Scales and weights recommended in Section 2.2. "Measurement Standards and Test Equipment" are suitable for the determination of drained weight.

- Sieves

  - For drained weight of 1.36 kg or (3 lb) or less, one 20 cm or (8 in) No. 8 mesh U.S. Standard Series Sieve, receiving pan, and cover

  - For drained weight greater than 1.36 kg or (3 lb), one 30 cm or (12 in) sieve, with same specifications as above

  Note: A U.S. Standard Test Sieve with 11.2 mm ($^{7}/_{16}$ in) openings must be used for canned tomatoes.

- Stopwatch

Test Procedure

Follow the Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" or a "Category B" sampling plan in the inspection (depending on the location of test); select a random sample; then use the following test procedure to determine lot compliance.

1. Use **Appendix E. "Standards Pack Inspection Report."** Fill out Boxes 1 through 8. Select the random sample. Determine and record on a worksheet the weight of the receiving pan.

2. Determine and record on a worksheet the gross weight of each individual package comprising the sample.

3. Pour the contents of the first package into the dry sieve with the receiving pan beneath it, incline sieve to an angle between 17° to 20° from horizontal to facilitate drainage, and allow the liquid from the product to drain into receiving pan for 2 minutes. (Do not shake or shift material on the sieve.) Remove sieve and product.

4. Weigh the receiving pan, liquid, wet container, and any other tare material. (Do not include sieve and product.) Record this weight as tare and receiving pan.

5. Subtract the weight of the receiving pan, determined in step 1, from the weight obtained in step 4 to obtain the package tare weight (which includes the weight of the liquid).

6. Subtract the tare weight, found in step 5, from the corresponding package gross weight determined in step 2 to obtain the drained weight of that package. Determine the package error (drained weight - labeled drained weight).

7. Repeat steps 3 through 6 for the remaining packages in the sample, cleaning and drying the sieve and receiving pan between measurements of individual packages.

8. Transfer the individual package errors to the Standard Pack Report form.

9. To determine lot conformance, return to Section 2.3. "Basic Test Procedures – Evaluating Results."

2.6. Drained Weight for Glazed or Frozen Foods

How is the drained weight of frozen shrimp (e.g., 2.27 kg (5 lb) block of shrimp) and crabmeat determined?

When determining the net weight of frozen shrimp and crabmeat, use the test equipment and procedure provided below. Immerse the product **(e.g., a block of frozen shrimp)** directly in water in a mesh basket or open container to thaw (e.g., it is not placed in a plastic bag). Direct immersion does not result in the product absorbing moisture because the freezing process causes the tissue to lose its ability to hold water. Maintain the water temperature between 23 °C to 29 °C (75 °F to 85 °F). This is accomplished by maintaining a constant flow of warm water into the container holding the product (e.g., place a bucket in a sink to catch the overflow, and feed warm water into the bottom of the bucket through a hose). After thawing, drain the product on a sieve for 2 minutes and then weigh it.

Equipment

- Partial immersion thermometer or equivalent with 1 °C (2 °F) graduations and a -35 °C to +50 °C (-30 °F to +120 °F) accurate to ±1 °C (±2 °F)

- Water source and hose with a**n approximate flow rate of** 4 L to 15 L (1 gal to 4 gal) per minute **for thawing blocks and other products** ~~**flow rate**~~

- Sink or other receptacle [i.e., **bucket with a capacity of approximately** 15 L (4 gal) ~~**bucket**~~] **for thawing blocks and other products**

- A wire mesh basket **(used for testing large frozen blocks of shrimp)** or other container that is large enough to hold the contents of 1 package (e.g., 2.27 kg or [5 lb] box of shrimp) and has openings small enough to retain all pieces of the product (e.g., an expanded metal test tube basket lined with standard 16 mesh screen)

- Number 8 mesh, 20 cm (8 in) or 30 cm (12 in) sieve

- Stopwatch

Test Procedure

Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" or a "Category B" sampling plan in the inspection (depending on the location of test); select a random sample; then use the following test procedure to determine lot compliance.

1. Place the unwrapped frozen shrimp or crabmeat in the wire mesh basket and immerse in a 15 L (4 gal) or larger container of fresh water at a temperature between 23 °C to 29 °C (75 °F to 85 °F). Submerge the basket so that the top of the basket extends above the water level.

2. Maintain a continuous flow of water into the bottom of the container to keep the temperature within the specified range.

3. As soon as the product thaws, determined by loss of rigidity, transfer all material to a sieve (20 cm [8 in] for packages less than 453 g [1 lb] or 30 cm [12 in] for packages weighing more than 453 g [1 lb]) and distribute it evenly over the sieve.

4. Without shifting the product, incline the sieve 30° from the horizontal position to facilitate drainage, and drain for 2 minutes.

5. At the end of the drain time, immediately transfer the product to a tared pan for weighing to determine the net weight.

How is the net weight of glazed ~~raw~~ seafood and fish determined?

For glazed seafood and fish, determine the net weight after removing the glaze using the following procedure. Use this method for any frozen glazed food product.

Equipment

Use the equipment listed in Section 2.6. "Drained Weight for Glazed or Frozen Foods."

Test Procedures

Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; and use the following test procedure to determine lot compliance.

1. Fill out a report form and select the random sample. A tare sample is not needed.

2. Weigh sieve and receiving pan. Record this weight on a worksheet as "sieve weight."

3. Remove each package from low temperature storage; open it immediately and place the contents under a gentle spray of cold water. **Handle the product with care** to avoid ~~**breaking**~~ **breakage**. ~~**the product**~~. Continue the spray**ing process** until all ice glaze, that is seen or felt is removed. In general, the product should remain rigid; however, the ice glaze on certain products, usually smaller sized commodities, sometimes cannot be removed without defrosting the product. Nonetheless, remove the glaze, because it is a substantial part of the package weight.

   (Amended 2002)

4. Transfer the product to the weighed sieve. Without shifting the product, incline the sieve to an angle of 17° to 20° to facilitate drainage and drain (into waste receptacle or sink) for exactly 2 minutes.

5. Place the product and sieve on the receiving pan and weigh. Record this weight on a worksheet as the "sieve + product weight."

6. The net weight of product is equal to the weight of the pan plus the sieve plus the product (recorded in step 5) minus the "sieve weight" (recorded in step 2). Record the product net weight on the worksheet. The package error is equal to the net weight of the product as measured minus the labeled weight. Record the package error on the worksheet and transfer it to the report form.

7. Repeat steps 3 through 6 for each package in the sample, cleaning and drying the sieve and the receiving pan between package measurements.

Evaluation of Results

Follow the procedures in Section 2.3. **"**Basic Test Procedure **–** Evaluating Results."

Chapter 3. Test Procedures – For Packages Labeled by Volume

3.1. Scope

What types of packaged goods can be tested using these procedures?

Use this procedure to determine the net contents of packaged goods labeled in fluid volume such as milk, water, beer, oil, paint, distilled spirits, soft drinks, juices, liquid cleaning supplies, or liquid chemicals. This chapter also includes procedures for testing the capacities of containers such as paper cups, bowls, glass tumblers, and stemware.

What types of packages are not covered by these procedures?

These procedures do not cover berry baskets and rigid-dry measures that are covered by specific code requirements in NIST Handbook 44. "Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices."

When can the gravimetric test procedure be used to verify the net quantity of contents of packages labeled by volume?

The gravimetric procedure may be used to verify the net quantity of contents of packages labeled in volume when the density (density means the weight of a specific volume of liquid determined at a reference temperature) of the product being tested does not vary excessively from one package to another.

What procedure is followed if the gravimetric test procedure cannot be used?

Test each package as described in Section 3.3. "Volumetric Test Procedure for Liquids."

What considerations besides density affect measurement accuracy?

In addition to possible package-to-package variations in product density, the temperature of the liquid will affect the volume of product. The product will expand or contract based on a rise or fall in product temperature.

> **Example:** The volume of a liquid cleaning product might be 5 L (1.32 gal) at 20 °C (68 °F) and 5.12 L (1.35 gal) at 25 °C (77 °F), which represents a 2.2 % change in volume.
>
> **Note:** This extreme example is for illustrative purposes, a 2.2 % volume change will not occur in normal testing.

What reference temperature should be used to determine the volume of a liquid?

Use the reference temperature specified in Table 3-1. "Reference Temperatures for Liquids" to determine volume. When checking liquid products labeled by volume using the gravimetric procedure, maintain the packages used to determine product densities at reference temperatures. If testing the packages in a sample volumetrically, each package in the sample must be maintained at or corrected to the reference temperature when its volume is determined.

Note. When checking liquid products using a volumetric or gravimetric procedure, the temperature of the samples must be maintained at the reference temperature ±2 °C (±5 °F).

If the Liquid Commodity is	Then, the reference temperature is
Frozen food labeled by volume (e.g., fruit juice)	-18 °C (0 °F)
Beer	3.9 °C (39.1 °F)
Food that must be kept refrigerated (e.g., milk and other dairy products. Usually labeled "Keep Refrigerated")	4.4 °C (40 °F)
Distilled spirits or petroleum	15 °C (60 °F)
Unrefrigerated products (e.g., includes liquids sold unchilled, such as soft-drinks and wine)	20 °C (68 °F)

3.2. Gravimetric Test Procedure for Liquids

Equipment

- A scale that meets the requirements in Chapter 2, Section 2.2. "Measurement Standards and Test Equipment."

  Note: To verify that the scale has adequate resolution for use, it is first necessary to determine the density of the liquid; next verify that the scale division is no larger than MAV/6 for the package size under test. The smallest graduation on the scale must not exceed the weight value for MAV/6.

  Example: Assume the inspector is using a scale with 1 g (0.002 lb) increments to test packages labeled 1 L (33.8 fl oz) that have an MAV of 29 mL (1 fl oz). Also, assume the inspector finds that the weight of 1 L of the liquid is 943 g (2.078 lb). This will result in an MAV/6 value in weight of 4.715 g (0.010 lb):

  29 mL/6 = 4.8 mL (1 fl oz/6 = 0.166 6 fl oz)

  943 g/1000 mL= 0.943 g/mL (2.07 8 lb/33.6 fl oz = 0.061 8 lb/fl oz)

  4.8 mL x 0.943 g/mL = 4.5264 g (0.166 6 fl oz x 0.061 8 lb/fl oz = 0.010 lb)

  In this example, the 1 g (0.002 lb) scale division is smaller than the MAV/6 value of 4.5264 g (0.10 lb) so the scale is suitable for making a density determination.

- A partial immersion thermometer (or equivalent) with a range of –35 °C to +50 °C (30 °F to 120 °F), at least 1 °C (1 °F) graduations, and with a tolerance of ±1 °C (±2 °F)

- Volumetric measures

  Example: When checking packages labeled in SI units, flask sizes of 100 mL, 200 mL, 500 mL, 1 L, 2 L, 4 L, and 5 L and a 50 mL cylindrical graduate with 1 mL divisions may be used. When checking packages labeled in inch-pound units the use of measuring flasks and graduates with capacities of gill, half-pint, pint, quart, half-gallon, gallon, and a 2 fl oz cylindrical graduate, graduated to ½ fl dr is recommended.

- Defoaming agents may be necessary for testing liquids such as beer and soft drinks that effervesce or are carbonated. Two such products are Hexanol or Octanol (Capryl Alcohol).

  Note: The mention of trade or brand names does not imply that these products are endorsed or recommended by the U.S. Department of Commerce over similar products commercially available from other manufacturers.

- Bubble level at least 15.24 cm (6 in) in length

- Stopwatch

Test Procedure

1. Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection. Select a random sample; then use the following procedure to determine lot compliance.

2. Bring the sample packages and their contents to the reference temperature as specified in Table 3-1. "Reference Temperatures for Liquids." To determine if the liquid is at its reference temperature, immerse the thermometer in the liquid before starting the test. Verify the temperature again immediately after the flask and liquid is weighed. If the product requires mixing for uniformity, mix it before opening in accordance with any instructions specified on the package label. Shaking liquids, such as flavored milk, often entraps air that will affect volume measurements, so use caution when testing these products. Often, less air is entrapped if the package is gently rolled to mix the contents.

3. For milk, select a volumetric measure equal to or one size smaller than the label declaration. For all other products, select a volumetric measure that is one size smaller than the label declaration. For example, if testing a 1 L bottle of juice or a soft drink, select a 500 mL volumetric measure.

   (Amended 2004)

Note: When determining the density of milk, if the product from the first container does not fill the volumetric measure to the nominal capacity graduation, product may be added from another container as long as product integrity is maintained (i.e., brand, identity, lot code, and temperature).

4. Prepare a clean volumetric measure to use according to the following procedures:

   - Because flasks are ordinarily calibrated on a "to deliver" basis, they must be "wet down" before using. Immediately before use, fill the volumetric flask(s) or graduate with water. The water should be at the reference temperature of the product being tested. Fill the flask(s) with water to a point slightly below the top graduation on the neck. The flask should be emptied in 30 seconds (± 5 seconds). Tilt the flask gradually so the flask walls are splashed as little as possible **<u>as the flask</u>** is emptied. When the main flow stops, the flask should be nearly inverted. Hold the flask in this position for 10 seconds more and touch off the drop of water that adheres to the tip. If necessary, dry the outside of the flask. The flask or graduate is then ready to fill with liquid from a package. This is called the "wet down" condition.

Note: When using a volumetric measure that is calibrated "to contain," the measure must be dry before each measurement.

- ➢ If the liquid effervesces or foams when opened or poured (such as carbonated beverages), add two drops of a defoaming agent to the bottom of the volumetric measure before filling with the liquid. If working with a carbonated beverage, make all density determinations immediately upon placing the product into the standard. This reduces the chance of volume changes occurring from the loss of carbonization.

- ➢ Before making additional measurements of a liquid, use water to wash or rinse and prepare the volumetric measure. Between each two measurements of liquid from the sample packages, prepare the volumetric measure as described above, dry the outside of the flask, and drain the volumetric measure as described in earlier paragraphs of this section, as appropriate.

5. If the flask capacity is equal to the labeled volume, pour the liquid into the volumetric measure tilting the package to a nearly vertical position. If the flask capacity is smaller than the package's labeled volume, fill the flask to its nominal capacity graduation. If conducting a volumetric test, drain the container into the volumetric measure for 1 minute after the stream of liquid breaks into drops.

6. Position the volumetric measure on a level surface at eye level. For clear liquids, place a material of some dark color outside the flask immediately below the level of the meniscus. Read the volume from the lowest point of the meniscus. For opaque liquids, read volume from the center top rim of the liquid surface.

7. Use the gravimetric procedure to determine the volume if the limit specified for the difference in density is not exceeded.

   - Select a volumetric measure equal to or one size smaller than the labeled volume (depending on the product) and prepare it as described in step 4 of this section. Then determine and record its empty weight.

   - Determine acceptability of the liquid density variation, using two packages selected for tare according to Section 2.3. "Basic Test Procedure – Tare Procedures" as follows:

     - ➢ Determine the gross weight of the first package.

     - ➢ Pour the liquid from the first package into a volumetric measure exactly to the nominal capacity marked on the neck of the measure.

     - ➢ Weigh the filled volumetric measure and subtract its empty weight to obtain the weight of the liquid. Determine density by dividing the weight of the liquid by the capacity of the volumetric measure.

     - ➢ Determine the weight of the liquid from a second package using the same procedure.

     - ➢ If the difference between the densities of the two packages exceeds one division, use the volumetric procedure in Section 3.3. "Volumetric Test Procedure for Liquids."

How is “nominal gross weight “determined?

Determine the “nominal gross weight” as follows:

1. Determine the Average Used Dry Tare Weight of the sample according to provisions of Section 2.3. “Basic Test Procedure – Tare Procedures.”

2. Calculate the Average Product Density by adding the densities of the liquid from the two packages and dividing the sum by two.

3. Calculate the “nominal gross weight” using the following formula if the flask capacity is equal to the labeled volume:

Nominal Gross Weight = (Average Product Density [in weight units]) + (Average Used Dry Tare Weight)

Note: If the flask size is smaller than the labeled volume, the following formula is used:

Nominal Gross Weight = (Average Product Density x [Labeled Volume/Flask Capacity]) + (Average Used Dry Tare Weight)

How are the errors in the sample determined?

1. Weigh the remaining packages in the sample.

   Subtract the nominal gross weight from the gross weight of each package to obtain package errors in terms of weight. All sample packages are compared to the nominal gross weight.

2. To convert the average error or package error from weight to volume, use the following formula:

Package Error in Volume = Package Error in Weight/Average Product Density
Per Volume Unit of Measure

Evaluation of Results

Follow the procedures in Chapter 2, Section 2.3. “Basic Test Procedure – Evaluating Results” to determine lot conformance.

3.3. Volumetric Test Procedure for Liquids

How is the volume of liquid contained in a package determined volumetrically?

Follow steps 1 through 6 in Section 3.2. “Gravimetric Test Procedure for Liquids” for each package in the sample.

How are the errors in the sample determined?

Read the package errors directly from the graduations on the measure. The reference temperature must be maintained within ± 2 °C (± 5 °F) for the entire sample.

Evaluation of Results

Follow the procedures in Chapter 2, Section 2.3. "Basic Test Procedure – Evaluating Results" to determine lot conformance.

3.4. Other Volumetric Test Procedures

What other methods can be used to determine the net contents of packages labeled by volume?

Depending on how level the surface of the commodity is, use one of two headspace test procedures. Use the first headspace test procedure to determine volume where the liquid has a smooth surface (e.g., oils, syrups, and other viscous liquids). Use the second procedure to determine volume where the commodity does not have a smooth surface (e.g., mayonnaise and salad dressing).

Test Procedure

Before conducting any of the following volumetric test procedures follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following procedure to determine lot compliance.

Test Equipment

- Micrometer depth gage (ends of rods fully rounded) 0 mm to 225 mm (0 in to 9 in) or longer
- Level (at least 15 cm (6 in) in length)
- Laboratory pipets and/or buret
  - Class A 500 mL buret that conforms to ASTM E287~~-94~~ **2(2007)**, "Standard Specification for Laboratory Glass Graduated Burets"
  - Class A Pipets, calibrated "to deliver" that conform to ASTM E969~~-95~~-**02(2007)**, "Standard Specification for Glass Volumetric (Transfer) Pipets"
- Volumetric measures
- Water
- Rubber bulb syringe
- Plastic disks that are 3 mm ($^1/_8$ in) thick with diameters equal to the seat diameter or larger than the brim diameter of each container to be tested. The diameter tolerance for the disks is 50 µm (± 0.05 mm [± 0.002 in]). The outer edge should be smooth and beveled at a 30° angle with the horizontal to 800 µm (0.8 mm [$^1/_{32}$ in]) thick at the edge. Each disk must have a 20 mm (¾ in) diameter hole through its center and a series of 1.5 mm ($^1/_{16}$ in) diameter holes 25 mm (1 in) **apart around the periphery of the disk and 3 mm ($^1/_8$ in)** from the outer edge. **All edges must be smooth**.
- Stopwatch

- **<u>Partial immersion thermometer (or equivalent) with a range of –35 °C to +50 °C (30 °F to 120 °F), at least 1 °C (1 °F) graduations, and with a tolerance of ± 1 °C (± 2 °F)</u>**

How is the volume of oils, syrups, and other viscous liquids that have smooth surfaces determined?

1. Make all measurements on a level surface.

2. Bring the temperature of both the liquid and the water to be used to measure the volume of the liquid to the reference temperature specified in Table 3-1. "Reference Temperatures for Liquids." **<u>Verify with a thermometer that product has maintained the reference temperature.</u>**

3. Measure the headspace of the package at the point of contact with the liquid using a depth gauge with a fully rounded, rather than a pointed, rod end. If necessary, support the package to prevent the bottom of the container from distorting.

4. Empty, clean, and dry the package.

5. Refill the container with water measured from a volumetric standard to the original liquid headspace level measured in step 3 of this section until the water touches the depth gauge.

6. Determine the amount of water used in step 5 of this section to obtain the volume of the liquid and calculate the "package error" based on that volume.

Evaluation of Results

Follow the procedures in Section 2.3. "Basic Test Procedure – Evaluating Results," to determine lot conformance.

3.5. Mayonnaise and Salad Dressing

Volumetric Headspace Test Procedure

Use the volumetric headspace procedure described in this section to determine volume when the commodity does not have a smooth surface (e.g., mayonnaise, salad dressing, and other water immiscible products without a level liquid surface). The procedure guides the inspector to determine the amount of headspace above the product in the package and the volume of the container. Determine the product volume by subtracting the headspace volume from the container volume. Open every package in the sample.

1. Make all measurements on a level surface.

2. Bring the temperature of both the commodity and the water used to measure the volume to the appropriate temperature designated in Table 3-1. "Reference Temperatures for Liquids."

3. Open the first package and place a disk larger than the package container opening over the opening.

4. Measurement Procedure

   - Deliver water from a flask (or flasks), graduate, or buret, through the central hole in the disk onto the top of the product until the container is filled. If it appears that the contents of the flask may overfill the container, do not empty the flask. Add water until all of the air in the container has been displaced and the water begins to rise in the center hole of the disk. Stop the filling procedure when the water fills the center disk hole and domes up slightly due to the surface tension. Do not add additional water after the level of the water dome has dropped.

- If the water dome breaks on the surface of the disk, the container has been overfilled and the test is void; dry the container and start over.

5. To obtain the headspace capacity, record the volume of water used to fill the container and subtract 1 mL (0.03 fl oz), which is the amount of water held in the hole in the disk specified.

6. Empty, clean, and dry the package container.

7. Repeat steps 4 and 5 of this section. Refill the package container with water measured from a volumetric measure to the maximum capacity of the package, subtract 1 mL (0.03 fl oz), and record the amount of water used as the container volume; and

8. From the container volume determined in step 7 of this section, subtract the headspace capacity in step 5 of this section to obtain the measured volume of the product and calculate the "package error" for that volume where "package error" equals labeled volume minus the measured volume of the product.

Evaluation of Results

Follow the procedures in Section 2.3. "Basic Test Procedure – Evaluating Results" to determine lot conformance."

3.6. Goods Labeled by Capacity – Volumetric Test Procedure

What type of measurement equipment is needed to perform the headspace test procedures?

Use the test equipment in Section 3.4. "Other Volumetric Test Procedures" (except for the micrometer depth gage) to perform these test procedures.

How is it determined if goods labeled by capacity meet the average and individual requirements?

Before conducting any of the following volumetric test procedures, refer to Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following test procedure to determine lot compliance.

1. Make all measurements on a level surface.

2. When testing goods labeled by capacity, use water at a reference temperature of 20 °C ± 2 °C (68 °F ± 5 °F).

3. Select a sample container and place a disk larger than the container opening over the opening.

4. Measurement Procedure

   - Add water to the container using flask (or flasks), graduate, or buret corresponding to labeled capacity of the container. If it appears that the contents of the flask may overfill the container, do not empty the flask. Add water until all of the air in the container has been displaced and the water begins to rise in the center hole of the disk. Stop filling the container when the water fills the center disk hole and domes up slightly due to the surface tension.

- If the water dome breaks on the surface of the disk, the container has been overfilled and the test is void; dry the container and start over.

- Record the amount of water used to fill the container and subtract 1 mL (0.03 fl oz) (this is the amount of water held in the hole in the disk specified) to obtain the total container volume.

5. Test the other containers in the sample according to the procedures in step 4 of this section.

6. To determine package errors, subtract the total container volume obtained in steps 4 and 5 of this section from the labeled capacity of the container.

Evaluation of Results

Follow the procedures in Section 2.3. "Basic Test Procedure – Evaluating Results" to determine lot compliance.

3.7. Pressed and Blown Glass Tumblers and Stemware

What requirements apply to pressed and blown glass tumblers and stemware?

This handbook provides a tolerance to the labeled capacity of glass tumblers and stemware. The average requirement does not apply to the capacity of these products. See Table 3-2. "Allowable Differences for Pressed and Blown Glass Tumblers and Stemware."

How is it determined if tumblers and stemware meet the individual package requirement?

Follow **Section 2.3.** "Basic Test Procedure **–** Define the Inspection Lot" and determine which sampling plan to use in the inspection, select a random sample, and then use the following volumetric test procedure to determine container capacity and volume errors.

What type of measuring equipment is needed to perform the test procedures?

Use the equipment specified in Section 3.4. "Other Volumetric Test Procedures," (except for the micrometer depth gage) to perform these test procedures.

What are the steps of the test procedure?

Follow steps 1 through 6 in Section 3.6. "Goods Labeled by Capacity – Volumetric Test Procedure."

How is it determined if the samples conform to the allowable difference?

Compare the individual container error with the allowable difference that applies in Table 3-2. "Allowable Differences for Pressed and Blown Glass Tumblers and Stemware." If a package contains more than one container, all of the containers in the package must meet the allowable difference requirements in order for the package to pass.

Table 3-2. Allowable Differences for Pressed and Blown Glass Tumblers and Stemware	
Unit of measure	
If the capacity in metric units is:	**Then the allowable difference is:**
200 mL or less	± 10 mL
More than 200 mL	± 5 % of the labeled capacity
If the capacity in inch-pound units is:	**Then the allowable difference is:**
5 fl oz or less	± ¼ fl oz
More than 5 fl oz	± 5 % of the labeled capacity

Evaluation of Results

Count the packages in the sample with volume errors greater than the allowable difference and compare the resulting number with the number given in Column 3.

- If the number of containers in the sample with errors exceeding the allowable difference exceeds the number allowed in Column 3, the lot fails.

- If the number of packages with errors exceeding the allowable difference is less than or equal to the number in Column 3, the lot passes.

Note: The average capacity error is not calculated because the lot passes or fails based on the individual volume errors. Act on the individual units containing errors exceeding the allowable difference individually even though the lot passes the requirement.

3.8. Volumetric Test Procedure for Paint, Varnish, and Lacquers – Non-aerosol

How is the volume of paint, varnish, and lacquers contained in a package determined?

Use one of three different test methods depending upon the required degree of accuracy and the location of the inspection. The procedures include both retail and in-plant audits and a "possible violation" method, which is designed, for laboratory or in plant use because of cleanup and product collection requirements. The procedures are suitable to use with products labeled by volume and packaged in cylindrical containers with separate lids that can be resealed.

Equipment

- A scale that meets the requirements in Section 2.2. "Measurement Standards and Test Equipment"

- Volumetric measures

- Micrometer depth gage (ends of rods fully rounded), 0 mm to 225 mm (0 in to 9 in)

- Diameter (Pi) tape measure, 5 cm to 30 cm (2 in to 12 in)

- Spanning bar, 2.5 cm by 2.5 cm by 30 cm or (1 in by 1 in by 12 in)

- Rule, 30 cm (12 in)

- Paint solvent or other solvent suitable for the product being tested
- Cloth, 30 cm (12 in) square
- Wood, 5 cm (2 in) thick, by 15 cm (6 in) wide, by 30 cm (12 in) long
- Rubber mallet
- Metal disk, 6.4 mm (¼ in) thick and slightly smaller than the diameter of package container bottom.
- Rubber spatula
- Level at least 15 cm (6 in) in length
- Micrometer (optional)
- Stopwatch

What test procedure is used to conduct a retail audit test?

Conduct a retail audit using the following test procedure that is suitable for checking cylindrical containers up to 4 L (1 gal) in capacity. Use step 2 in the retail audit test procedure with any size container, but step 3 must be used for containers with capacities of 4 L (1 gal). The method determines the volume of a single can in the sample selected as most likely to contain the smallest volume of product. Do not empty any containers because only their critical dimensions are being measured.

How accurate is the dimensional test procedure?

The configuration of the bottom of the can, paint clinging to the lid, and slight variations in the wall and label thicknesses of the paint container may produce an uncertainty estimated to be at least 0.6 % in this auditing procedure. Therefore, this method is recommended solely to eliminate from more rigorous testing those packages that appear to be full measure. Use the violation procedures when the volume determined in step 10 is less than the labeled volume or in any case where short measure is suspected.

What worksheets make data recording easier?

Use the following format to develop worksheets to perform audits and determine the volume when checking paint. Follow the procedure and it will indicate the column in which the various measurements made can be recorded.

Example: Audit Worksheet for Checking Paint – Add additional rows as needed									
1. Can Height	Can Diameter				6. Avg Liquid Diameter	7. Avg Liquid Level	8. Avg Container Depth	9. Avg Liquid Depth	10. Volume*
	2. Top	3. Middle	4. Bottom	5. Average					
*10. Volume = 0.7854 x 6 x 6 x 9									

Note: When the following instructions require recording a measurement, refer to the numbered columns in the "Audit Worksheet for Checking Paint" shown above.

How is a retail audit test performed?

1. Select a random sample. A tare sample is not needed.

2. For containers less than 4 L or (1 gal): measure the outside diameter of each container near its middle to the closest 0.02 mm (0.001 in). Use a diameter tape measure to record the measurements in Column 3. Place the containers on a level surface and using the micrometer depth gage, record their heights in Column 1 on the worksheet. If the range of outside diameters exceeds 0.125 mm (0.005 in) or the range in heights exceeds 1.58 mm (0.062 5 in), do not use this procedure. If the ranges are within the specified limits, weigh all cans in the sample, select the container with the lightest gross weight, and remove its lid. Continue with step 4 below.

3. For 4 L (1 gal) containers: gross weigh each package in the sample. Select the package with the lightest gross weight and remove its lid.

4. Use a direct reading diameter tape measure to measure the outside diameter of the selected container near its top, middle (already measured if step 2 was followed), and bottom to the closest 0.02 mm (0.001 in). Record these measurements in Columns 2, 3, and 4. Add the three diameter values and divide by three to obtain the average diameter and record this value in Column 5.

5. If a micrometer is available, measure the wall and the paper label thickness of the container; otherwise, assume the wall and label thicknesses given in Table 3-3. "Thickness of Paint Can Walls and Labels" below:

Table 3-3. Thickness of Paint Can Walls and Labels	
Can Size	**Wall Thickness**
4 L (1 gal)	250 µm (0.25 mm) [0.010 in]
2 L (½ gal)	250 µm (0.25 mm) [0.010 in]
1 L (1 qt)	230 µm (0.23 mm) [0.009 in]
500 mL (1 pt)	230 µm (0.23 mm) [0.009 in}
250 mL	200 µm (0.20 mm) [0.008 in]
Label Thickness* for all can sizes: 100 µm (0.10 mm) [0.004 in] (*Paper only – ignore labels lithographed directly onto the container)	

Subtract twice the thickness of the wall of the can and paper label from the average can diameter (step 4) to obtain the average liquid diameter. Record the liquid diameter in Column 6.

6. On a level surface, place the container on the circular metal disk that is slightly smaller in diameter than the lower rim of the can so the bottom of the container nests on the disk to eliminate any "sag" in the bottom of the container.

7. Place the spanning bar and depth gage across the top of the paint can and mark the location of the spanning bar on the rim of the paint container. Measure the distance to the liquid level, to the nearest 20 µm (0.02 mm) (0.001 in), at three points in a straight line. Take measurements at points approximately 1 cm (3/8 in) from the inner rim for cans 12.5 cm (5 in) in diameter or less (and at 1.5 cm [½ in] from the rim for cans exceeding 12.5 cm [5 in]) in diameter and at the center of the can. Add the three readings and divide by three to obtain the average distance to the liquid level in the container. Record the average distance to the liquid level in Column 7.

8. Measure the distance to the bottom of the container at three points in a straight line in the same manner as outlined in step 7. Add the three readings and divide by three to obtain the average height of the container and record it in Column 8.

9. Subtract the average distance to the liquid level (Column 7) from the average height of the container (Column 8) to obtain the average height of the liquid column and record it in Column 9.

10. Determine the volume of paint in the container by using the following formula:

$$\text{Volume} = 0.7854\ D^2H$$

Where D = average liquid diameter (Column 6) and H = average liquid height (Column 9)

11. Record this value in Column 10. If the calculated volume is less than labeled volume, go to the Violation Procedure.

How is an in-plant audit conducted?

Use the following procedures to conduct an in-plant audit inspection. This method applies to a container that probably contains the smallest volume of product. Duplicate the level of fill with water in a can of the same dimensions as the one under test. Use this method to check any size of package if the liquid level is within the measuring range of the depth gage. If any paint is clinging to the sidewall or lid, carefully scrape the paint into the container using a rubber spatula.

1. Follow steps 1 through 6 of the retail audit test.

2. Place the spanning bar and depth gage across the top of the paint can. Measure the liquid level at the center of the surface and record the level in Column 7.

3. Select an empty can with the same bottom configuration as the container under test and with a diameter and height equal to that of the container under test within plus or minus the following tolerances:

   a. For 500 mL or (1 pt) cans – within 25 µm (0.025 mm) (0.001 in)
   b. For 1 L or (1 qt) cans – within 50 µm (0.05 mm) (0.002 in)
   c. For 2 L or (½ gal) cans – within 75 µm (0.075 mm) (0.003 in)
   d. For 4 L or (1 gal) cans – within 100 µm (0.1 mm) (0.004 in)

   Set the empty can on a level work surface with a circular metal disk that is slightly smaller in diameter than the bottom can rim underneath the can to eliminate sag. Set up the spanning bar and depth gage as in step 2 above. Fill the container with water from a volumetric measure of the same volume as the labeled volume. Measure the distance to the liquid level at the center of the container and record this level in Column 7 below the reading recorded in step 2. If this distance is equal to or greater than the distance determined in step 2, assume that the package is satisfactory. If the distance is less than the distance determined in step 2, the product may be short measure. Use the "Violation Procedure" in the next section when the audit test indicates that short measure is possible.

Violation Procedure

How is it determined if the containers meet the package requirements?

Use the following method if the liquid level is within the measuring range of the micrometer. The first step is to follow the "Basic Test Procedure" in Section 2.3. Define the inspection lot to determine which "Category A" sampling plan to use; select a random sample; and then use the following procedure. The steps noted with an (*) are required if there is paint adhering to the lid and it cannot removed by scraping into the can.

1. Do not shake or invert the containers selected as the sample. Determine the gross weight of these packages and record in Column 2 of the "Example Worksheet for Possible Violation in Checking Paint" below.

Example Worksheet for Possible Violation in Checking Paint – Add additional rows as needed								
1. Labeled Volume	2. Gross Weight	3. Lid Paint Weight (Wet - Dry)	4. Liquid Level	5. Tare	6. Water Volume	7. Net Wt. = 2 - 5	8. Weight of Labeled Volume = 7 x 1 ÷ 6	9. Package Volume = 6 + [(3 ÷ 7) x 6)]

Record the labeled volume of the first tare sample package in Column 1 of the worksheet. Use a circular metal disk to eliminate can "sag" and remove the lid. If paint clings to the lid of the container, scrape it off with a spatula.

2.* If paint that adheres to the lid cannot be completely removed by scraping the paint into the can, determine the weight of the lid plus any adhering paint. Clean the paint lid with solvent and weigh again. Subtract the clean lid weight from the lid weight with paint to determine the weight of the paint adhering to the lid. Record this weight in Column 3.

3. Place the spanning bar and depth gage across the top of the paint can. Mark the location of the spanning bar on the rim of the paint container. Measure the distance to the liquid level at the center of the container to the nearest 20 μm (0.02 mm) (0.001 in). Record the distance in Column 4.

4. Empty and clean the sample container and lid with solvent; dry and weigh the container and lid. Record the tare weight in Column 5.

5. Set up the container in the same manner as in step 1.

6. Place the spanning bar at the same location on the rim of the paint container as marked in step 3. With the depth gage set as described in step 3, deliver water into the container in known amounts until the water reaches the same level occupied by the paint as indicated by the depth gage. Record this volume of water (in mL or fl oz) in Column 6 of the worksheet. This is the volume occupied by the paint in the container. Follow steps, 7a, 8a, and 9a if scraping does not remove the paint from the lid. In order to determine if gravimetric testing can be used to test the other packages in the sample, follow only steps 7, 8, and 9 when no paint adheres to the lid.

7. Subtract the weight of the container (Column 5) from the gross weight (Column 2) to arrive at the net weight of paint in the selected container. Record the net weight in Column 7 of the worksheet.

   7a* Subtract the weight of the container (Column 5) and the weight of product on the lid (Column 3) from the gross weight (Column 2) to arrive at the net weight of paint in the container. Record in Column 7 (excluding the weight of the paint on the lid).

8. Calculate the weight of the labeled volume of paint (for the first package opened for tare = on the lid).

   net weight (Column 7) x labeled volume (Column 1) ÷ volume of paint in can (Column 6)

   Record this value in Column 8.

   8a* Calculate the package volume =

   volume in can (Column 6) + (lid paint weight [Column 3] x
   volume in can [Column 6] / net weight [Column 7]]

   Record it in Column 9 of the worksheet.

9. Calculate the package error. Use the following formula if paint does not adhere to the lid:

   Package error = (Column 6 value) - (labeled volume)

   9a* Use the following formula if paint does adhere to the lid and will not come off by scraping.

   Package error = (Column 9 value) - (labeled volume)

10. Repeat steps 1 through 9 for the second package chosen for tare.

When can a gravimetric procedure be used?

A gravimetric procedure is used if the weights of the labeled volume for the first two packages do not differ from each other by more than one division on the scale (if they meet this criterion, check the rest of the sample gravimetrically and record in Column 8).

How is "nominal gross weight" determined?

Determine the "Nominal Gross Weight" for use with Chapter 2, Section 2.3. "Basic Test Procedure" as follows:

The nominal gross weight equals the sum of the average weight of the labeled volume (average of values recorded in Column 8) plus the average tare (average of values recorded in Column 3) for the packages selected for tare. Note that the weight of a given volume of paint often varies considerably from container to container; therefore, volumetric measurements may prove necessary for the entire sample.

Evaluation of Results

Follow the procedures in Section 2.3. "Basic Test Procedures – Evaluating Results" to determine lot conformance.

3.9. Testing Viscous Materials – Such As Caulking Compounds and Pastes

How are viscous materials such as caulking compounds and paste tested?

Use the following procedure for any package of viscous material labeled by volume. It is suitable for very viscous materials such as cartridge-packed caulking compounds, glues, pastes, and other similar products. It is best to conduct this procedure in a laboratory using a hood to ventilate solvent fumes. If used in the field, use in a well ventilated area. Except for the special measurement procedures to determine the weight of the labeled volume, this procedure follows the basic test procedure. For each weight of a known volume determination, pack a portion of the packaged product into a pre-weighed cup of known volume (called a "density cup" or "pycnometer") and weigh. From the weight of the known volume, determine the weight of the labeled volume. Compare the nominal gross weight with the gross weight to determine the package error.

What type of measurement equipment is needed to test packages of caulk, pastes, and glues?

- A scale that meets the requirements in Section 2.2. "Measurement Standards and Test Equipment."

- Pycnometer, a vessel of known volume used for weighing semifluids. The pycnometer can be bought or made. If it is made, refer to it as a "density cup." To make a 150 mL or 5 fl oz density cup, cut off the lip of a 150 mL beaker with an abrasive saw and grind the lip flat on a lap wheel. The slicker plate is available commercially. Calibrate the density cup gravimetrically with respect to the contained volume using the procedure in ASTM E42~~—94~~**01(2007)**, "Standard Practice for Calibration of Laboratory Volumetric Apparatus."

- Appropriate solvents (water, Stoddard solvent, kerosene, alcohol, etc.)

- Caulking gun (for cartridge packed products)

How is a pycnometer prepared for use?

Before using, weigh and calibrate the pycnometer (or the density cup and slicker plate) with respect to volume (mL or fl oz). If applicable, comply with any special instructions furnished by the manufacturer to calibrate a pycnometer that has not been calibrated. It is not necessary to reweigh or recalibrate for each test; however, mark the pieces of each unit to prevent interchange of cups and slicker plates.

How is it determined if the containers meet the package requirements?

1. ~~**First,**~~ Follow ~~**the "Basic Test Procedure" in**~~ Section 2.3. **"Basic Test Procedure. –** Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then, use the following procedure to determine lot compliance.

2. Weigh a calibrated pycnometer and slicker plate and record as "pycnometer weight" and record this weight and the volume of the pycnometer.

3. Determine the gross weight of the first package and record the weight value. Open the package and transfer the product to the pycnometer by filling it to excess. Use a caulking gun to transfer product from the caulking cartridges. If using a pycnometer, cover it with a lid and screw the cap down tightly. Excess material will be forced out through the hole in the lid, so the lid must be clean. If using a density cup, place the slicker plate over ¾ of the cup mouth, press down and slowly move the plate across the remainder of the opening. With the slicker plate in place, clean all the exterior surfaces with solvent and dry.

4. Completely remove the product from the package container; clean the package container with solvent; dry and weigh it to determine the tare weight.

5. Weigh the filled pycnometer or filled density cup with slicker plate and record this weight. Subtract the weight of the empty pycnometer from the filled weight to determine the net weight of the product contained in the pycnometer and record this weight.

6. Clean the pycnometer and repeat steps 3, 4, and 5 for the second package in the tare sample.

   Determine acceptability of the density variation on the two packages selected for tare. If the difference between the densities of both packages exceeds one division of the scale, do not use the gravimetric procedure to determine the net quantity of contents. Instead, use the procedure in steps 9 and 10.

   Note: If the gravimetric procedure can be used, perform steps 8 and 10.

7. Calculate the weight of product corresponding to the labeled volume of product according to the following formula:

   Weight of Product in Pycnometer ÷ Pycnometer Volume = Product Density

8. Test each package individually by determining the product density in each package using the pycnometer and record the gross, tare, and net weight of each package. Subtract the weight of the labeled volume (determined for each package) from the net weight of product to arrive at each individual package error in units of weight.

9. Convert the package errors to units of volume using the following formula:

Package Error (volume) = (Package Error [weight] x Pycnometer Volume) ÷ (Weight of Product in Pycnometer)

10. Record the package errors on the report form using an appropriate unit of measure.

Evaluation of Results

Follow the procedures in Section 2.3. "Basic Test Procedure – Evaluation Results" to determine lot conformance.

3.10. Peat Moss

How are packages of peat and peat moss labeled by compressed volume tested?

Measure the dimensions of the compressed material to determine if it contains the labeled quantity.

How are packages of peat and peat moss labeled by uncompressed volume tested?

Use the following method to test peat moss sold using an uncompressed volume as the declaration of content. The procedure is based on ASTM D2978-~~90~~ **03**, "Standard Method of Test for Volume of Processed Peat Materials."

Equipment

- 12.7 mm (or ½ in) sieve.
- Use one of the following measures as appropriate for the package size. (Refer to Table 3-4. "Specifications for Test Measures for Mulch and Soils" for additional information on test measure construction.)
    - 28.3 L (1 ft^3) measure with inside dimensions of 30.4 cm (12 in) by 30.4 cm (12 in) by 30.4 cm (12 in). Mark the inside of the measure with horizontal lines every 1.2 cm (½ in) so that package errors can be directly determined.
    - 100 L (3.5 ft^3) measure with inside dimensions of 50 cm (19.68 in) by 50 cm (19.68 in) by 40 cm (15.74 in). The inside of the measure should be marked with horizontal lines every 1.2 cm (½ in) so that package errors can be directly determined.
- Straight edge, 50.8 cm (20 in) in length.
- Sheet for catching overflow of material.
- Level (at least 15.24 cm (6 in) in length).

How is it determined if the packages meet the requirements in this handbook?

1. Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then, use the following procedure to determine lot compliance.

2. Open each package in turn, remove the contents, and pass them through the sieve directly into the measuring container (overfilling it). Use this method for particulate solids (such as soils or other garden materials) labeled in cubic dimensions or dry volume. Some materials may not pass through the sieve for peat moss; in these instances, separate the materials by hand (to compensate for packing and settling of the product after packaging) before filling the measure.

   Note: Separated material (product not passing through the sieve) must be included in the product volume.

   Shake the measuring container with a rotary motion at one rotation per second for 5 seconds. Do not lift the measuring container when rotating it. If the package contents are greater than the measuring container capacity, level the measuring container with a straight edge using a zigzag motion across the top of the container. Empty the container. Repeat the filling operations as many times as necessary, noting the partial fill of the container for the last quantity delivered using the interior horizontal markings as a guide. Record the total volume.

3. To compute each package error, subtract the labeled quantity from the total volume and record it.

Evaluation of Results

Follow the procedures in Section 2.3. "Basic Test Procedure – Evaluating Results" to determine lot conformance.

3.11. Mulch and Soils Labeled by Volume

What products are defined as mulch and soil?

- Mulch is defined as "any product or material except peat or peat moss that is advertised, offered for sale, or sold for primary use as a horticultural, above-ground dressing, for decoration, moisture control, weed control, erosion control, temperature control, or other similar purposes."

- Soil is defined as "any product or material, except peat or peat moss that is advertised or offered for sale, or sold for primary use as a horticultural growing media, soil amendment, and/or soil replacement."

What type of measurement equipment is needed to test packages of mulch and soil?

- A test measure appropriate for the package size that meets the specifications for test measures in Table 3-4. "Specifications for Test Measures for Mulch and Soils."

<table>
<tr><th colspan="6">Table 3-4. Specifications for Test Measures for Mulch and Soils</th></tr>
<tr><th rowspan="2">Nominal Volume of Test Measure</th><th colspan="3">Interior Wall Dimensions*</th><th rowspan="2">Marked Intervals on Interior Walls ***</th><th rowspan="2">Volume Equivalent of Marked Intervals</th></tr>
<tr><th>Length</th><th>Width</th><th>Height**</th></tr>
<tr><td>30.2 L (1.07 ft^3) for testing packages that contain less than 28.3 L (1 ft^3 or 25.7 dry qt)</td><td colspan="2">203.2 mm (8 in)</td><td>736.6 mm (29 in)</td><td rowspan="4">12.7 mm (½ in)</td><td>524.3 mL (32 in^3)</td></tr>
<tr><td>28.3 L (1 ft^3)</td><td colspan="3">304.8 mm (12 in)</td><td rowspan="3">1 179.8 mL (72 in^3)</td></tr>
<tr><td>56.6 L (2 ft^3)</td><td rowspan="2">406.4 mm (16 in)</td><td rowspan="2">228.6 mm (9 in)</td><td rowspan="2">1219.2 mm (48 in)</td></tr>
<tr><td>84.9 L (3 ft^3)</td></tr>
<tr><td colspan="6">Measures are typically constructed of 12.7 mm <s>1.27 cm</s> (½ in) marine plywood. A transparent sidewall is useful for determining the level of fill, but must be reinforced if it is not thick enough to resist distortion. If the measure has a clear front, place the level gage at the back (inside) of the measure so that the markings are read over the top of the mulch.

Notes:
* Other interior dimensions are acceptable if the test measure approximates the configuration of the package under test and does not exceed a base configuration of the package cross-section.
** The height of the test measure may be reduced, but this will limit the volume of the package that can be tested.
*** When lines are marked in boxes, they should extend to all four sides of the measure if possible to improve readability. It is recommended that a line indicating the MAV level also be marked to reduce the possibility of reading errors when the level of the mulch is at or near the MAV.</td></tr>
</table>

- Drop cloth/polyethylene sheeting for catching overflow of material.

- Level (at least 15 cm [6 in] in length).

How is it determined if the packages meet the package requirements?

Use the following procedure:

1. Follow the Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection, select a random sample, then use the following procedure to determine lot conformance.

2. Open each package in turn. Empty the contents of the package into a test measure and level the contents by hand. Do not rock, shake, drop, rotate, or tamp the test measure. Read the horizontal marks to determine package net volume.

Note: Some types of mulch are susceptible to clumping and compacting. Take steps to ensure that the material is loose and free flowing when placed into the test measure. Gently roll the bag before opening to reduce the clumping and compaction of material.

3. Exercise care in leveling the surface of the mulch/soil and determine the volume reading from a position that minimizes errors caused by parallax.

How are package errors determined?

Determine package errors by subtracting the labeled volume from the package net volume in the measure. Record each package error.

Package Error = Package Net Volume - Labeled Volume

Evaluation of Results

Follow the procedures in Section 2.3. "Basic Test Procedure – Evaluating Results" to determine lot conformance.

Note: In accordance with Appendix A, Table 2-10. Exceptions to the Maximum Allowable Variations for Textiles, Polyethylene Sheeting and Film, Mulch and Soil Labeled by Volume, Packaged Firewood and Packages Labeled by Count with Fewer than 50 Items, apply an MAV of 5 % of the declared quantity to mulch and soil sold by volume. When testing mulch and soil with a net quantity in terms of volume, one package out of every 12 in the sample may exceed the 5 % MAV (e.g., one in a sample of 12 packages; two in a sample of 24 packages; four in a sample of 48 packages.) However, the sample must meet the average requirement of the "Category A" Sampling Plan.

3.12. Ice Cream Novelties

Note: The following procedure can be used to test packaged products that are solid or semisolid and that will not dissolve in, mix with, absorb, or be absorbed by the fluid into which the product will be immersed. For example, ice cream labeled by volume can be tested using ice water or kerosene as the immersion fluid.

How are ice cream novelties inspected to see if the labeled volume meets the package requirements?

Use the following volume displacement procedure that uses a displacement vessel specifically designed for ice cream novelties such as ice cream bars, ice cream sandwiches, or cones. The procedure determines the volume of the novelty by measuring the amount of water displaced when the novelty is submerged in the vessel. Two displacements per sample are required to subtract the volume of sticks or cups.

The procedure first determines if the densities of the novelties are the same from package to package (in the same lot) so that a gravimetric test can be used to verify the labeled volume. If a gravimetric procedure is used, compute an average weight for the declared volume from the first two packages and weigh the remainder of the sample. If the gravimetric procedure cannot be used, use the volume displacement procedure for all of the packages in the sample.

Equipment

- A scale that meets the requirements in Section 2.2. "Measurement Standards and Test Equipment."
- Volumetric measures

Displacement vessel with dimensions that is appropriate for the size of novelties being tested. Figure 3-1. Example of a Displacement Vessel shows an example of a displacement vessel. It includes an interior baffle that reduces wave action when the novelty is inserted and the downward angle of the overflow spout reduces dripping. Other designs may be used.

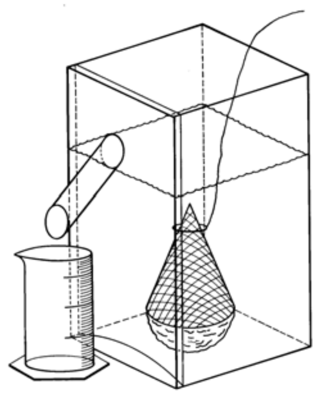


Figure 3-1. Example of a Displacement Vessel

Note: This displacement vessel can be constructed or similar devices may be obtained from any Laboratory Equipment or Science Education suppliers. The U.S. Department of Commerce does not endorse or recommend any particular device over similar commercially available products from other manufacturers.

- Thin wire, clamp, or tongs
- Freezer or ice chest and dry ice
- Single-edged razor or sharp knife (for sandwiches only)
- Ice water/kerosene maintained at 1 °C (33 °F) or below
- Indelible marker (for ice pops only)
- Level, at least 15.24 cm (6 in) in length
- A partial immersion thermometer (or equivalent) with a range of -1 °C to +50 °C (30 °F to 120 °F), at least 1 °C (1 °F) graduations, and with a tolerance of ±1 °C (±2 °F)
- A table-top, laboratory-type jack of sufficient size to hold the displacement vessel
- Stopwatch

Test Procedure

Follow the in Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following procedure to determine lot compliance.

1. Maintain the samples at the reference temperature for frozen products that is specified in Table 3-1. "Reference Temperatures for Liquids" (i.e., -18 °C [0 °F]). Place the samples in the freezer or ice chest until they are ready to be tested, and then remove packages from the freezer one at a time.

2. According to the type of novelty, prepare the sample products as follows:

   - Ice-pop. Mark on the stick(s) with the indelible marker the point to which the pop will be submerged in the ice water. (After the ice-pop contents have been submerged, remove the novelty to determine the volume of the stick.)

   - Cone. Make a small hole in the cone below the ice cream portion to allow air to escape.

   - Sandwich. Determine whether the declared volume is (a) the total volume of the novelty (that is, including the cookie portion) or (b) the volume of the ice-cream-like portion only. If the declared volume is the volume of only the ice-cream-like portion, shave off the cookie with a razor or knife, leaving some remnants of cookie to ensure that no ice cream is accidentally shaved off. Work quickly, and return the novelty to the freezer before the sandwich softens.

   - Cup. Remove the cap from the cup. (After the cup and novelty contents have been submerged, remove the novelty from the cup to determine the volume of the cup.)

How is it determined if the ice cream novelty packages meet the requirements in this handbook?

1. Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following procedure to determine lot compliance.

2. Fill the displacement vessel with ice water until it overflows the spout. Allow it to sit until dripping stops. Raise the displacement vessel as necessary and place the graduate beneath the spout.

3. Remove a package from the freezer, determine its gross weight and record it.

4. Submerge the novelty as suggested until it is below the surface level of the water.

   - Ice-pop. Use a clamp, tongs, or your fingers to hold the stick(s) and submerge the pop to the level marked in step 2 of the Test Procedures.

   - Cone. Shape the wire into a loop, and use it to push the cone, headfirst (ice cream portion first) into the ice water. Do not completely submerge the cone immediately: let water fill the cone through the hole made in step 2 of the Test Procedures before completely submerging the novelty.

   - Sandwich or cup. Skewer the novelty with the thin wire or form a loop on the end of the wire to push the sandwich or ice-cream portion or cup completely below the liquid level.

5. Record the total water volume in the graduate. For a cone or sandwich, record the water volume as the net volume and go to step 7. For ice-pops or cups, record the water volume in the graduate as the gross volume and go to step 6.

6. Refill the displacement vessel with water to overflowing and reposition the empty graduate under the spout.

   - Ice-pop. Melt the ice pop off the stick or sticks. Submerge the stick or sticks to the line marked in step 4. Record the volume of tare material (i.e., stick) by measuring the water displaced into the graduate. The net volume for the ice-pop is the gross volume recorded in step 5 minus the volume of the tare materials in this step. Record this volume as the "volume of novelty." To determine the error in the package, subtract the labeled quantity from the volume of novelty.

   - Cup. Remove the novelty from the cup. Rinse the cup, and then submerge it in the displacement vessel. Small pinholes in the base of the cup can be made to make submersion easier. Record the volume of water displaced into the graduate by the cup as the volume of tare material. The net volume for the novelty is the gross volume determined in step 5 minus the volume of the tare materials determined in this step. Record this as the net volume of the novelty. To determine the error in the package, subtract the labeled quantity from the volume of novelty.

7. Clean and air-dry the tare materials (sticks, wrappers, cup, lid, etc.). Weigh and record the weight of these materials for the package.

8. Subtract the tare weight from the gross weight to obtain the net weight and record this value.

9. Compute the weight of the labeled volume for the package using the following formula and then record the weight:

   Product Density = (weight in item 3) ÷ (the total water volume in step 5)
   Weight of labeled volume = (labeled volume) x (Product Density)

10. Repeat steps 3 through 9 for a second package.

11. If the weight of the labeled volume in steps 9 and step 10 differ from each other by more than one division on the scale, the gravimetric test procedure cannot be used to test the sample for compliance. If this is the case, steps 2 through 6 for each of the remaining packages in the sample must be used to determine their net volumes and package errors. Then go to evaluation of results.

How is "nominal gross weight" determined?

1. Use Section 2.3. "Basic Test Procedure – Tare Procedure" to determine the Average Used Dry tare Weight of the sample.

2. Using the weights determined in step 11 calculate the Average Product Weight by adding the densities of the liquid from the two packages and dividing the sum by two.

3. Calculate the "nominal gross weight" using the formula:

   Nominal Gross Weight = Average Product Weight + Average Used Dry Tare Weight

How are the errors in the sample determined?

1. Weigh the remaining packages in the sample.

2. Subtract the nominal gross weight from the gross weight of each package to obtain package errors in terms of weight.

Note: Compare the sample packages to the nominal gross weight.

3. Follow Section 2.3. "Basic Test Procedure."

   To convert the average error or package error from weight to volume, use the following formula:

$$\text{Package Error in Volume} = (\text{Package Error in Weight}) \div (\text{Product Density})$$

Evaluation of Results

Follow the procedures in Section 2.3. "Basic Test Procedure – Evaluating Results" to determine lot conformance.

3.13. Fresh Oysters Labeled by Volume

What requirements apply to packages of fresh oysters labeled by volume?

Packaged fresh oysters removed from the shell must be labeled by volume. The maximum amount of permitted free liquid is limited to 15 % by weight. Testing the quantity of contents of fresh oysters requires the inspector to determine total volume, total weight of solids and liquid, and the weight of the free liquid.

Equipment

- A scale that meets the requirements in Section 2.2. "Measurement Standards and Test Equipment"

- Volumetric measures

- Micrometer depth gage (ends of rods fully rounded), 0 mm to 228 mm (0 in to 9 in)

- Strainer for determining the amount of drained liquid from shucked oysters. Use as a strainer a flat bottom metal pan or tray constructed to the following specifications:

  - Sides: 5.08 cm (2 in)

  - Area: 1935 cm^2 (300 in^2) or more for each 3.78 L (1 gal) of oysters **(Note: Strainers of smaller area dimensions are permitted to facilitate testing smaller containers.)**

- Perforations:
  Diameter: 6.35 mm (¼ in)
  Location: 3.17 cm (1¼ in) apart in a square pattern, or perforations of equivalent area and distribution.

- Spanning bar, 2.54 cm by 2.54 cm by 30.48 cm (1 in by 1 in by 12 in)
- Rubber spatula
- Level, at least 15.24 cm (6 in) in length
- Stopwatch

How is it determined if the containers meet the package requirements?

Follow the Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then, use the following test procedure to determine lot compliance.

1. Determine and record the gross weight of a sample package.

2. Set the container on a level surface and open it. Use a depth gage to determine the level of fill. Lock the depth gauge. Mark the location of the gauge on the package.

3. Weigh a dry 20.32 cm or 30.48 cm (8 in or 12 in) receiving pan and record the weight. Set strainer over the receiving pan.

4. Pour the contents from the container onto the strainer without shaking it. Tip the strainer slightly and let it drain for 2 minutes. Remove strainer with oysters. It is normal for oysters to include mucous (which is part of the product) that will not pass through the strainer, so do not force it.

5. Weigh the receiving pan and liquid and record the weight. Subtract the weight of the dry receiving pan from the weight of pan and liquid to obtain the weight of free liquid and record the value.

6. Clean, dry, and weigh the container and record the tare weight. Subtract the tare weight from the gross weight to obtain the total weight of the oysters and liquid and record this value.

7. Determine and record the percent of free liquid by weight as follows:

   Percent of free liquid by weight = [(weight of free liquid) ÷ (weight of oysters + liquid)] x 100.

8. Set up the depth gauge on the dry package container as in step 2. Pour water from the flasks and graduate as needed to re-establish the level of fill obtained in step 2. Add the volumes delivered as the actual net volume for the container and record the value.

Note: Some containers will hold the declared volume only when filled to the brim; they may have been designed for other products, rather than for oysters. If the net volume is short-measure (per step 8), determine if the container will reach the declared volume only if filled to the brim. Under such circumstance, the package net volumes will all be short measure because the container cannot be filled to the brim with a solid and liquid mixture. A small headspace is required in order to get the lid into the container without losing any liquid.

Evaluation of Results

Follow the procedures in Section 2.3. “Basic Test Procedure” Evaluating Results to determine lot conformance.

3.14. Determining the Net Contents of Compressed Gas in Cylinders

What type of compressed gases may be tested with these procedures?

These procedures are for industrial compressed gas. Compressed gas may be labeled by weight (for example, Liquefied Petroleum [LP] gas, or carbon dioxide) or by volume. Acetylene, liquid; oxygen, nitrogen, nitrous oxide, and argon are all filled by weight. Acetylene is sold by liters or by cubic feet. Helium, gaseous oxygen, nitrogen, air, and argon are filled according to pressure and temperature tables.

What type of test procedures must be used?

Checking the net contents of compressed gas cylinders depends on the method of labeling; those labeled by weight are generally checked by weight. Cylinders filled by using pressure and temperature charts must be tested using a pressure gauge that is connected to the cylinder. Determine the volume using the pressure and temperature of the cylinder.

Should any specific safety procedures be followed?

Yes, be aware of the hazards of the high pressure found in cylinders of compressed gas. An inspector should handle compressed gas only if the inspector has been trained and is knowledgeable regarding the product, cylinder, fittings, and proper procedures (see *Compressed Gas Association [CGA] pamphlet P-1, “Safe Handling of Compressed Gases in Containers*,” for additional information). Additional precautions that are necessary for personal safety are described in the CGA Handbook of Compressed Gases. All personnel testing compressed gases should have this manual for reference and be familiar with its contents. It is essential that the inspector be certain of the contents before connecting to the cylinder. Discharging a gas or cryogenic liquid through a system for which the material is not intended could result in a fire and/or explosion or property damage due to the incompatibility of the system and the product. Before connecting a cylinder to anything, be certain of the following:

- Always wear safety glasses.

- The cylinder is clearly marked or labeled with the correct name of the contents and that no conflicting marks or labels are present. Do not rely on the color of the cylinder to identify the contents of a cylinder. Be extremely careful with all gases because some react violently when mixed or when coming in contact with other substances. For example, oxygen reacts violently when it comes in contact with hydrocarbons.

- The cylinder is provided with the correct Compressed Gas Association (CGA) connection(s) for the product. A proper connection will go together smoothly; so excessive force should not be used. Do not use an adapter to connect oxygen to non-oxygen cleaned equipment. When a cylinder valve is opened to measure the internal pressure, position the body away from the pressure gauge blowout plug or in front of the gauge if the gauge has a solid cast front case. If the bourdon tube should rupture, do not be in a position to suffer serious injuries from gas pressure or fragments of metal.

- Thoroughly know the procedure and place emphasis on safety precautions before attempting any tests. Do not use charts referred to in the procedure until the necessary training has been completed. When moving a cylinder, always place the protective cap on the cylinder. Do not leave spaces between cylinders when moving them. This can lead to a "domino" effect if one cylinder is pushed over.

- Open all valves slowly. A failure of the gauge or other ancillary equipment can result in injuries to nearby persons. Remember that high gas pressure can propel objects with great force. Gas ejected under pressure can also cause serious bodily injuries if someone is too close during release of pressure.

- One of the gauges will be reserved for testing oxygen only and will be prominently labeled "For Oxygen Use Only." This gauge must be cleaned for oxygen service and maintained in that "clean" condition. The other gauge(s) may be used for testing a variety of gases if they are compatible with one another.

- Observe special precautions with flammable gas in cylinders in addition to the several precautions necessary for the safe handling of any compressed gas in cylinders. Do not "crack" cylinder valves of flammable gas before connecting them to a regulator or test gauge. This is extremely important for hydrogen or acetylene.

What type of measurement equipment is needed to test cylinders of compressed gas?

- Use a scale that meets the requirements in Section 2.2. "Measurement Standards and Test Equipment." Use a wooden or non-sparking metal ramp to roll the cylinders on the scale to reduce shock loading.

- Two calibrated precision bourdon tube gauges or any other approved laboratory-type pressure-measuring device that can be accurately read within plus or minus 40 kPa (5 psi). A gauge having scale increments of 200 kPa (25 psi) or smaller shall be considered as satisfactory for reading within plus or minus 40 kPa (5 psi). The range of both gauges shall be a minimum of 0 kPa to 23 MPa (0 psi to 5000 psi) when testing cylinders using standard industrial cylinder valve connections. These standardized connections are listed in "CGA Standard V-1, Standard for Compressed Gas Cylinder Valve Outlet and Inlet for use with Gas Pressures up to 21 MPa (3000 psi)." For testing cylinders with cylinder valve connections rated for over 21 MPa (3000 psi), the test gauge and its inlet connection must be rated at 14 MPa (2000 psi) over the maximum pressure that the connection is rated for in CGA V-1. **Note:** There are standard high-pressure industrial connections on the market that are being used up to their maximum pressure of 52 MPa (7500 psi).

  Note: Any gauge or connectors used with oxygen cylinders must be cleaned for oxygen service, transported in a manner which will keep them clean and never used for any other gas including air or oxygen mixtures. Oxygen will react with hydrocarbons and many foreign materials that may cause a fire or explosion.

- An approved and calibrated electronic temperature measuring device or three calibrated mercury-in-glass thermometers having either a digital readout or scale division of no more than 1 °F

(0.5 °C). The electronic device equipped with a surface temperature sensor is preferred over a mercury-in-glass thermometer because of its shorter response time.

- Two box-end wrenches of 29 mm (1 1/8 in) for oxygen, nitrogen, carbon dioxide, argon, helium, and hydrogen and 22 mm (7/8 in) for some sizes of propane. All industrial CGA connections are limited to these two hex sizes. Avoid using an adjustable wrench because of the tendency to round the edges of the fittings, which can lead to connections not being tightened properly.

- Use a separate gauge and fitting for each gas to be tested. If adapters must be used, do not use on oxygen systems.

Test Procedure for Cylinders Labeled by Weight

How is it determined if the containers meet the package requirements using the gravimetric test procedure?

1. Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following test procedure to determine lot compliance.

2. The cylinder should be marked or stenciled with a tare weight. The marked value may or may not be used by the filling plant when determining the net weight of those cylinders sold or filled by weight. If there is a tare weight marked on the net contents tag or directly on the cylinder, then an actual tare weight was determined at the time of fill. If there is no tare weight marked on a tag or on the cylinder, then the stamped or stenciled tare weight is presumed to have been used to determine the net contents.

   Note: Check the accuracy of the stamped tare weights on empty cylinders whenever possible. The actual tare weight must be within (a) ½ % of the stamped tare weight for 9.07 kg (20 lb) tare weights or less or (b) ¼ % of the stamped tare weight for greater than 9.07 kg (20 lb) tare weights. (See NIST Handbook 130, "Method of Sale Regulation.")

3. Place cylinder on scale and remove protective cap. The cap is not included in the tare weight. Weigh the cylinder and determine net weight, using either the stamped or stenciled tare weight, or the tare weight marked on the tag. Compare actual net weight with labeled net weight, or use the actual net weight to look up the correct volume declaration (for Acetylene Gas), and compare that with the labeled volume.

   Note: The acetone in acetylene cylinders is included in the tare weight of the cylinder. Therefore, as acetylene is withdrawn from the cylinder, some acetone will also be withdrawn, changing the tare weight.

   Most producers will replace acetone in the cylinder before the cylinder is refilled, filling the cylinder with acetone to the stamped tare weight. Other producers, although not following recommended procedures, do not replace the acetone until it drops to a predetermined weight. In the latter situation, the refilling plant must note the actual tare weight of the cylinder and show it on the tag containing the net content statement or on the cylinder itself. Refer to tables for acetylene if necessary (if the acetylene is labeled by volume).

Test Procedure for Cylinders Labeled by Volume

How is it determined if the containers meet the package requirements using the volumetric test procedure?

1. Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following test procedure to determine lot compliance.

2. Determine the temperature of the cylinders in the sample. Place the thermometer approximately halfway up a cylinder in contact with the outside surface. Take the temperature of three cylinders selected at random and use the average temperature of the three values.

3. Using the appropriate pressure gauge, measure the pressure of each cylinder in the sample.

4. Determine the cylinder nominal capacity from cylinder data tables or from the manufacturer. (These tables must be obtained in advance of testing.)

5. Using NIST Technical Note 1079 "Tables of Industrial Gas Container Contents and Density for Oxygen, Argon, Nitrogen, Helium, and Hydrogen" determine the value (SCF/CF) from the content tables at the temperature and pressure of the cylinder under test.

6. Multiply the cylinder nominal capacity by the value (SCF/CF) obtained from the content tables. This is the actual net quantity of gas.

7. Subtract the labeled net quantity from the actual net quantity to determine the error.

Evaluation of Results

Follow Section 2.3. "Basic Test Procedures – Evaluating Results" to determine lot conformance.

3.15. Volumetric Test Procedure for Packaged Firewood with a Labeled Volume of 113 L (4 ft^3) or Less

How are packages of firewood tested?

Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample, then use the test procedure provided in Section 3.17. **"Crosshatched Firewood"** to determine lot compliance.

Equipment

- Linear Measure. Take all measurements in increments of 0.5 cm ($^3/_{16}$ in) or less and round up.

- Binding Straps. Binding Straps are used to hold wood bundles together if the bundles need to be removed from the package/wrapping material.

How is it determined if the containers meet the package requirements?

Unless otherwise indicated, take all measurements without rearranging the wood or removing it from the package. If the layers of wood are crosshatched or not ranked in discrete sections in the package, remove the wood from the package re-stack and measure accordingly.

3.16. Boxed Firewood

How is the volume of firewood contained in a box determined?

Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following test procedure to determine lot conformance.

1. Open the box to determine the average height of wood within the box; measure the internal height of the box. Take three measurements (record as "d_1, d_2...etc.") along each end of the stack. Measure from the bottom of a straight edge placed across the top of the box to the highest point on the two outermost top pieces of wood and the center-most top piece of wood. Round measurements down to the nearest 0.5 cm ($^1/_8$ in). If pieces are obviously missing from the top layer of wood, take additional height measurements at the highest point of the uppermost pieces of wood located at the midpoints between the three measurements on each end of the stack. Calculate the average height of the stack by averaging these measurements and subtracting from the internal height of the box according to the following formula.

   Average Height of Stack =
   (Internal Height of Box) – (sum of measurements) ÷ (number of measurements)

2. Determine the average width of the stack of wood in the box by taking measurements at three places along the top of the stack. Measure the inside distance from one side of the box to the other on both ends and in the middle of the box. Calculate the average width.

   $$\text{Average Width} = (W_1 + W_2 + W_3) \div (3)$$

3. To determine the average length of the pieces of wood, remove the wood from the box and select the five pieces with the greatest girth. Measure the length of each of the five pieces from center-to-center. Calculate the average length of the five pieces.

   $$\text{Average Length} = (L_1 + L_2 + L_3 + L_4 + L_5) \div (5)$$

4. Calculate the volume of the wood within the box. Use dimensions for height, width, and length.

   Volume in liters = (height in cm x width in cm x length in cm) ÷ (1000)

   Volume in cubic feet = (height in inches x width in inches x length in inches) ÷ (1728)

5. For boxes of wood that are packed with the wood ranked in two discrete sections perpendicular to each other, calculate the volume of wood in the box as follows: (1) determine the average height, width, and length as in 1, 2 and 3 above for each discrete section, compute total volume, and (2) total the calculated volumes of the two sections. Take the width measurement for Volume 2 (V_2) from the inside edge of the box adjacent to V_2 to the plane separating V_1 and V_2. Compute total volume by adding Volume 1 (V_1) and V_2 according to the following formula.

$$\text{Total Volume} = V_1 + V_2$$

6. Follow Section 2.3. "Basic Test Procedure – Evaluating Results" to determine lot conformance.

3.17. Crosshatched Firewood

How must the volume of stacked or crosshatched firewood be measured?

Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; and use the following test procedure to determine lot compliance.

1. Stack the firewood in a ranked and well-stowed geometrical shape that facilitates volume calculations (i.e., rectangular). The number of measurements for each dimension given below is the minimum that should be taken.

2. Determine the average measurements of the stack:

   - Height: Start at one end of the stack; measure the height of the stack on both sides at four equal intervals. Calculate and record the average height.

   - Length: Start at the base of the stack; Measure the length of the stack in four equal intervals. Calculate and record the average length.

   - Width: Select the five pieces with the greatest girth. Measure the length of the pieces, calculate and record the average piece length. (3)

   Calculate Volume:

   Volume in liters = (Avg. Height [cm] x Avg. Width [cm] x Avg. Length in [cm]) ÷ 1000

   Volume in cubic feet = (Avg. Height [in] x Avg. Width [in] x Avg. Length [in]) ÷ 1728

3. Follow Section 2.3. "Basic Test Procedure – Evaluating Results" to determine lot conformance.

3.18. Bundles and Bags of Firewood

How is the volume of bundles and bags of firewood measured?

Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following test procedure to determine lot compliance.

1. Average area of ends: secure a strap around each end of the bundle or bag of wood to prevent movement during testing and to provide a definite perimeter. Use two or more straps to secure the wood.

2. Set one end of the bundle or bag on tracing paper large enough to cover the end completely. Draw a line around the perimeter of the bundle or bag on the tracing paper.

3. Transfer the tracing paper to a template graduated in square centimeters or square inches. Count the number of square centimeters or square inches that are enclosed within the perimeter line. Estimate portions of square centimeters or square inches not completely within the perimeter line to the nearest one-quarter square inch.

4. Repeat this process on the opposite end of the bundle or bag.

5. Calculate the Average Area:

$$\text{Average Area} = (\text{Area } 1 + \text{Area } 2) \div 2$$

6. Average length of the pieces of wood – select the five pieces with the greatest girth and measure the length of the pieces. Calculate the average length of the pieces of wood:

$$\text{Average Length} = (L_1 + L_2 + L_3 + L_4 + L_5) \div 5$$

7. Calculate Volume:

$$\text{Volume in liters} = (\text{Average Area [cm}^2\text{] x Average Length [cm]}) \div 1000$$

$$\text{Volume in cubic feet} = (\text{Average Area [in}^2\text{] x Average Length [in]}) \div 1728$$

Evaluation of Results

Follow Section 2.3. "Basic Test Procedure – Evaluating Results" to determine lot conformance.

Note: Specified in Appendix A, Table 2-10. "Exceptions to the Maximum Allowable Variations for Textiles, Polyethylene Sheeting and Film, Mulch and Soil Labeled by Volume, Packaged Firewood, and Packages Labeled by Count with Fewer than 50 Items." – maximum allowable variations for individual packages are not applied to packages of firewood.

Chapter 4. Test Procedures – Packages Labeled by Count, Linear Measure, Area, Thickness, and Combinations of Quantities

4.1. Scope

What types of packaged goods can be tested using these procedures?

Use these procedures to determine the net contents of products sold by count, area, thickness, and linear measure. If a package includes more than one declaration of quantity, each declaration must meet the package requirements.

Can the gravimetric test procedure be used to verify the net quantity of contents of packages labeled by count and linear measure?

Use the gravimetric procedure (below) to test products sold by measure or count if the density of the product does not vary excessively from one package to another.

What procedures may be used if the gravimetric test procedure cannot be used?

Open each package in the sample and measure or count the items.

4.2 Packages Labeled by Count

How are packages labeled by count tested?

If the labeled count is 50 items or less fewer, use Section 4.3. "Packages Labeled with 50 Items or Fewer." If the labeled count is more than 50 items, see Section 4.4. "Packages Labeled by Count of More than 50 Items."

How to determine if a gravimetric test procedure be used to verify the labeled count of a package?

Yes, if the scale being used is sensitive enough to determine the weight of individual items. Use the following procedures to determine if the sample packages can be tested gravimetrically.

1. For packages labeled with a count of 84 or higher, calculate the weight equivalent for the MAV/6 for the labeled count of the package. MAV/6 must be at least equal to one-half scale division on a mechanical scale or one division on a digital scale.

2. For packages with a labeled count of 83 or fewer, when each unit weighs at least 2 scale divisions, consider the scale acceptable.

Example: According to Appendix A, Table 2-7. Maximum Allowable Variations (MAVs) for Packages Labeled by Count – the MAV is 7 for a package labeled with a count of 250 items. The scale should be capable of measuring differences corresponding to MAV/6 or, in this example, the weight of one item.

- If the scale meets the appropriate requirement, gravimetric testing can be used to determine package count or,

- If the scale does not meet the criteria, count the content in each package in the sample.

4.3. Packages Labeled with 50 Items or Fewer

Test Procedure

1. Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following test procedure to determine lot compliance.

2. Open the packages and count the number of items in each. Record the number of packages that contain fewer than the labeled count.

Evaluation of Results

1. For the sample size indicated in Column 1 of Appendix A, Table 2-11. "Accuracy Requirements for Packages Labeled by Low Count of (50 or fewer) and Packages Given Tolerance (Glass and Stemware)," refer to Column 2 to determine the number of packages that are allowed to contain fewer than the labeled count.

2. If the number of packages in the sample that contain fewer than the labeled count exceeds the number permitted in Column 2, the sample and the lot fail to meet the package requirement.

   Note: For statistical reasons, the average requirement does not apply to packages labeled by count of 50 or fewer items, and the MAV does not apply to the lot. It only applies to the packages in the sample.

3. Maximum Allowable Variations: The MAVs listed in Appendix A, Table 2-7. "Maximum Allowable Variations (MAVs) for Packages Labeled by Count" define the limits of reasonable variation for an individual package even though the MAV is not directly used in the sampling plan. Individual packages that are undercount by more than the MAV are considered defective. Even if the sample passes, these should be repacked, relabeled, or otherwise handled.

   Example: If testing a lot of 160 packages of pencils labeled "50 pencils," choose a random sample of 12 packages from the lot. If the scale cannot discriminate between differences in count, open every package and count the pencils. For example, assume the 12 package counts are: 50, 52, 50, 50, 51, 53, 52, 50, 50, 50, 47, and 50.

   Because only one package contains fewer than 50 pencils, the sample passes the test (refer to Appendix A. Table 2-11. "Accuracy Requirements for Packages Labeled by Low Count [50 or Fewer] and Packages Given Tolerances [Glass and Stemware]"). However, the package containing 47 pencils should not be introduced into commerce even though the lot complies with the package requirements because it is undercount by more than the MAV (1 item) permitted in Appendix A, Table 2-7. "Maximum Allowable Variations (MAVs) for Packages Labeled by Count."

4.4. Packages Labeled by Count of More than 50 Items

Test Procedures

There are two procedures to determine count without opening all packages in the sample. Both use the weight of a counted number of items in the package. If the weight of discrete items or numbers of items in a package varies, the packaged items must be counted rather than weighed.

Equipment

Use a scale that meets the requirements in Section 2.2. "Measurement Standards and Test Equipment."

Audit Procedure

Use this procedure to audit lots of packages labeled by count of more than 50 items, but the precision of this procedure is only ± 1 %. Determine the lot compliance based on actual count or the violation procedure.

1. Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following test procedure to determine lot compliance.

2. Select an initial tare sample according to Section 2.3. "Basic Test Procedure – Tare Procedures."

3. Gross weigh the first package in the tare sample and record this weight.

4. Select the number of items from the first tare package that weighs the greater:

   - 10 % of the labeled count; or

   - a quantity equal to at least 50 minimum divisions on the scale.

   Example: Using a scale with 1 g divisions, the selected count must weigh at least 50 grams. If a scale with 0.001 lb divisions is used, the selected count must weigh at least 0.05 lb. Record the count and weight.

5. Calculate the weight of the labeled count using the following formula:

   $$\text{Weight of the Labeled Count} = (\text{labeled count x weight of items in step 4}) \div (\text{count of items in step 4})$$

   Record the result as "labeled count weight."

6. Gross weigh the remaining packages of the tare sample and keep contents of opened packages separated in case all of the items must be counted.

7. Determine the Average Used Dry Tare Weight of the sample according to Section 2.3. "Basic Test Procedure – Tare Procedures."

8. The weight of the labeled count plus the average tare weight represents the "nominal gross weight."

9. Subtract the nominal gross weight from the gross weight of the individual packages and record the errors.

   (Package error [weight]) = (actual package gross weight) **-** (nominal gross weight)

10. Convert the package errors in units of weight to count:

    Package error (count) = (Package error [weight] x labeled count) ÷ (labeled count weight)

    Round any fractional counts up to whole items in favor of the packager. Record the package error in units of count. Compute the average error.

    - If the average error is minus, go to the "procedure to use if the inspector suspects the lot violates the package requirements" below.

    - If the average error is zero or positive, the sample is presumed to conform to the package requirements.

Procedures to use if the inspector suspects the lot violates the package requirements

If possible, use the gravimetric procedure to determine compliance. To minimize the number of packages to be opened, combine the measurement of the weight of the number of units in the package with the determination of tare. Therefore, it will not be necessary to open more packages than the tare sample. If the audit procedure in this section has been used, the possible violation procedure below can be followed with the same sample if package contents have been kept separate and can still be counted. Use the following steps to determine if the sample passes or fails.

1. Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following test procedure to determine lot compliance. Use a scale that meets the criteria specified in 4.2. "Packages Labeled by Count."

2. Select an initial tare sample according to Section 2.3. "Basic Test Procedure – Tare Procedures."

3. Gross weigh the packages selected for the tare sample and record these weights. Open these packages and determine the tare and net weights of the contents, and count the exact number of items in the packages. Record this information.

4. Calculate and record the weights of the labeled counts for the first two packages using the formula:

   Weight of labeled count = (labeled count) x (contents weight ÷ contents count)

To avoid round off errors, carry at least two extra decimal places in the calculation until the weight of the labeled count is obtained. To use the gravimetric procedure, the difference in weights of the labeled counts of the two packages must not exceed one scale division.

- If the difference in weights exceeds this criterion, determine the actual count per package for every package in the sample recording plus and minus errors. Then, follow the procedures in Section 2.3. "Basic Test Procedure – Evaluating Results" to determine lot conformance.

- If the difference is within the criterion, average the weights of the labeled count and go on to step 5.

5. Determine the Average Used Dry Tare Weight of the sample according to provisions in Section 2.3. "Basic Test Procedure – Tare Procedures."

6. Determine and record the nominal gross weight by adding the average weight of the labeled count of items in the package step 4 to the average tare weight step 5.

7. Weigh the remaining packages in the sample, subtract the nominal gross weight from the gross weight of the individual packages, and record the errors.

   Package Error (weight) = (Actual Package Gross Weight) - (Nominal Gross Weight)

8. Look up the MAV for the package size from Appendix A, Table 2-7. "Maximum Allowable Variations (MAVs) for Packages Labeled by Count" and convert it to weight using the formula:

   MAV (weight) = (MAV (count) x Avg. Wt. of Labeled Count [from step 4]) ÷ (Labeled Count)

   Convert the MAV to dimensionless units by dividing the MAV (weight) by the unit of measure and record.

Evaluation of Results

Follow the procedures in Section 2.3. "Basic Test Procedure – Evaluation Results" to determine lot conformance.

Convert back to count when completing the report form using the following formula:

Avg. Pkg. Error (count) = (Avg. Pkg. Error [dimensionless units]) x (Unit of Measure) x (Labeled Count) ÷ (Avg. Weight of Labeled Count)

4.5. Paper Plates and Sanitary Paper Products

How are the labeled dimensions of paper plates and sanitary paper products verified?

Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following procedure to determine lot compliance.

The following procedures are used to verify the size of paper plates and other products. The following procedure may be used to verify the size declarations of other disposable dinnerware.

Note: Do not distort the item's shape during measurement.

The count of sanitary paper products cannot be adequately determined by weighing. Variability in sheet weight and core weight requires that official tests be conducted by actual count. However, weighing can be a useful audit method. These products often declare total area as well as unit count and sheet size. If the actual sheet size measurements and the actual count comply with the average requirements, the total area declaration is assumed correct.

Equipment

- Steel tapes and rules. Determine measurements of length to the nearest division of the appropriate tape or rule.

  - Metric Units:

    For labeled dimensions 40 cm or less, Linear Measure: 30 cm in length, 1 mm divisions; or a 1 m rule with 0.1 mm divisions, overall length tolerance of 0.4 mm.

    For labeled dimensions greater than 40 cm, 30 m tape with 1 mm divisions.

  - Inch-pound Units:

    For labeled dimensions 25 in or less, use a 36 in rule with $^{1}/_{64}$ in or $^{1}/_{100}$ in divisions and an overall length tolerance of $^{1}/_{64}$ in.

    For dimensions greater than 25 in, use a 100 ft tape with $^{1}/_{16}$ in divisions and an overall length tolerance of 0.1 in.

- Measuring Base

  Note: A measuring base may be made of any flat, sturdy material approximately 38 cm (15 in) square. Two vertical side pieces approximately 3 cm (1 in) high and the same length as the sides of the measuring base are attached along two adjoining edges of the measuring base to form a 90° corner. Trim all white borders from two or more sheets of graph paper (10 divisions per centimeter or 20 divisions per inch). Place one sheet on the measuring base and position it so that one corner of graph paper is snug in the corner of the measuring base and vertical sides. Tape the sheet to the measuring base. Overlap other sheets on the first sheet so that the lines of top and bottom sheet coincide, expanding the graph area to a size bigger than plates to be measured; tape these sheets to the measuring base. Number each line from the top and left side of base plates: 1, 2, 3, etc.

How are paper products inspected?

1. Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following test procedure to determine lot compliance.

2. Select an initial tare sample according to Section 2.3. "Basic Test Procedure – Tare Procedure."

3. Open each package and select one item from each.

Note: Some packages of plates contain a combination of different-sized plates. In this instance, take a plate of each declared size from the package to represent all the plates of that size in the package. For example, if three sizes are declared, select three different plates from each package.

How are paper products measured?

Note: Occasionally, packages of plates declared to be one size contain plates that can be seen by inspection to be of different sizes in the same package. In this instance, select the smallest plate and use the methods below to determine the package error. If the smallest plate is not short measure by more than the MAV, measure each size of plate in the package and calculate the average dimensions.

> **Example:** If 5 plates measure 21.41 cm (8.43 in) and 15 measure 21.74 cm (8.56 in), the average dimension for this package of 20 plates is 21.66 cm (8.53 in).

4. For paper plates: place each item on the measuring base plate (or use the linear measure) with the eating surface down so two sides of the plate touch the sides of the measuring base. For other products, use either the measuring base or a linear measure to determine actual labeled dimensions (e.g., packages of napkins, rolls of paper towels). If testing folded products, be sure that the folds are pressed flat so that the measurement is accurate.

5. If the measurements reveal that the dimensions of the individual items vary, select at least 10 items from each package. Measure and average these dimensions. Use the average dimensions to determine package error in step 5 below.

6. The package error equals the actual dimensions minus the labeled dimensions.

Evaluation of Results

Follow the procedures in Section 2.3. "Basic Test Procedure – Evaluating Results" to determine lot conformance.

4.6. Special Test Requirements for Packages Labeled by Linear or Square Measure (Area)

Are there special measurement requirements for packages labeled by dimensions?

Yes, products labeled by length (such as yarn) or area, often requires the application of tension to the ends of the product in order to straighten the product before measuring. When testing yarn and thread apply tension and use the specialized equipment specified in ASTM D1907-~~9~~ **07**, "Standard Test Method for Linear Density of Yarn (Yarn Number) by the Skein Method," in conjunction with the sampling plans and package requirements described in this handbook.

Evaluation of Results

Follow the procedures in Section 2.3. "Basic Test Procedure – Evaluating Results" to determine lot conformance.

4.7. Polyethylene Sheeting

Which procedures are used to verify the declarations on polyethylene sheeting and bags?

Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following test procedure to determine lot compliance.

Note: Most polyethylene products are sold by length, width, thickness, area, and net weight.

Equipment

- A scale that meets the requirements in Section 2.2. "Measurement Standards and Test Equipment."

- Steel tapes and rules determine measurements of length to the nearest division of the appropriate tape or rule.

  - Metric Units:

    For labeled dimensions 40 cm or less, Linear Measure: 30 cm in length, 1 mm divisions; or a 1 m rule with 0.1 mm divisions, overall length tolerance of 0.4 mm.

    For labeled dimensions greater than 40 cm, 30 m tape with 1 mm divisions.

  - Inch-pound Units:

    For labeled dimensions 25 in or less, use a 36 in rule with $^{1}/_{64}$ in or $^{1}/_{100}$ in divisions and an overall length tolerance of $^{1}/_{64}$ in.

    For dimensions greater than 25 in, use a 100 ft tape with $^{1}/_{16}$ in divisions and an overall length tolerance of 0.1 in.

- Deadweight dial micrometer (or equal) equipped with a flat anvil, 6.35 mm or (¼ in) diameter or larger, and a 4.75 mm ($^{3}/_{16}$ in) diameter flat surface on the head of the spindle. The anvil and spindle head surfaces should be ground and lapped, parallel to within 0.002 mm (0.0001 in), and should move on an axis perpendicular to their surfaces. The dial spindle should be vertical, and the dial should be at least 50.8 mm (2 in) in diameter. The dial indicator should be continuously graduated to read directly to 0.002 mm (0.0001 in) and should be capable of making more than one revolution. It must be equipped with a separate indicator to indicate the number of complete revolutions. The dial indicator mechanism should be fully jeweled. The frame should be of sufficient rigidity that a load of 1.36 kg (3 lb) applied to the dial housing, exclusive of the weight or spindle presser foot, will not cause a change in indication on the dial of more than 0.02 mm (0.001 in). The indicator reading must be repeatable to 0.001 2 mm (0.000 05 in) at zero. The mass of the probe head (total of anvil, weight 102 g or [3.6 oz], spindle, etc.) must be 113.4 g (4 oz). The micrometer should be operated in an atmosphere free from drafts and fluctuating temperature and should be stabilized at ambient room temperature before use.

- Gage blocks covering the range of thicknesses to be tested should be used to check the accuracy of the micrometer
- T-square

Test Procedure

1. Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following test procedure to determine lot compliance.

2. Be sure the product is not mislabeled. Check the label declaration to confirm that all of the declared dimensions are consistent with the required standards. The declaration on sheeting, film, and bags shall be equal to or greater than the weight calculated by using the formulas below. Calculate the final value to four digits and declare to three digits dropping the final digit (e.g., if the calculated value is 2.078 lb, then the declared net weight is truncated to 2.07 lb).

Example Label:

Polyethylene Sheeting
1.82 m (6 ft) x 30.48 m (100 ft)
101.6 µm (4 mil)
5.03 kg (11.1 lb*)*

3. Use the following formulas to compute a target net weight. The labeled weight should equal or exceed the target net weight or the package is not in compliance.

➢ For metric dimensions:

Target Mass in Kilograms = (T x A x D) ÷ 1 000

Where: T = nominal thickness in centimeters

A = nominal length in centimeters x nominal width (the nominal width for bags is twice the labeled width) in centimeters

D = density in grams per cubic centimeter*

- For inch-pound dimensions:

Target Weight in Pounds = T x A x D x 0.036 13

Where: T = nominal thickness in inches;

A = nominal area; that is the nominal length in inches x nominal width (the nominal width for bags is twice the labeled width) in inches;

D = density in grams per cubic centimeter; 0.036 13 is a factor for converting $^{g}/_{cm^3}$ to $^{lb}/_{in^3}$.

*Determined by ASTM Standard D1505~~-98~~ 03, "Standard Method of Test for Density of Plastics by the Density Gradient Technique." For the purpose of this handbook, the minimum density shall be 0.92 g/cm^3 when the actual density is not known.

Evaluation

1. Perform the calculations as shown in the following samples. If the product complies with the label declaration, go to step 2.

Sample Calculations

- For metric units:

(0.010 16 cm x [(1.82 m x 100 $^{cm}/_{m}$) x (30.48 m x 100 $^{cm}/_{m}$)] x 0.92 $^{g}/_{cm^3}$) ÷ 1000 $^{g}/_{kg}$
= a target net mass of 5.18 kg

In this example, the labeled net mass of 5.03 kg does not meet the target net mass, so the product is not in compliance.

- For inch-pound units:

(0.004 in) x [(6 ft x 12 $^{in}/_{ft}$) x (100 ft x 12 $^{in}/_{ft}$)] x 0.92 $^{g}/_{cm^3}$ x 0.03613 = a target net weight of 11.48 lb

In this example, the labeled net weight of 11.1 lb does not meet the target net weight, so the product is not in compliance.

1. Select packages for tare samples. Determine and record the gross weights of the initial tare sample.

2. Extend the product in the sample packages to their full dimensions and remove by hand all creases and folds.

3. Measure the length and width of the product to the closest 3 mm ($^1/_8$ in). Make all measurements at intervals uniformly distributed along the length and width of the sample and record the results. Compute the average length and width, and record.

   - With rolls of product, measure the length of the roll at three points along the width of each roll and measure the width at a minimum of 10 points along the length of each roll.

   - For folded products, such as drop cloths or tarpaulins, make three length measurements along the width of the sample and three width measurements along the length of the sample.

4. Determine and record the average tare weight according to Section 2.3. "Basic Test Procedures – **<u>Tare Procedures.</u>**"

Evaluation of Results – Length, Width, and Net Weight

Follow the procedures in Section 2.3. "Basic Test Procedure – Evaluating Results" to determine the lot conformance requirements for length, width, and weight.

- If the sample fails to meet the package requirements for any of these declarations, no further measurements are necessary. The lot fails to conform.

- If the sample meets the package requirements for the declarations of length, widths, and weight, go to step 6 to verify the thickness declaration.

Measure the thickness of the plastic sheet with a micrometer using the following guide. Place the micrometer on a solid level surface. If the dial does not read zero with nothing between the anvil and the spindle head, set it at zero. Raise and lower the spindle head or probe several times; it should indicate zero each time. If it does not, find and correct the cause before proceeding.

- Take measurements at five uniformly distributed locations across the width at each end and five locations along each side of each roll in the sample. If this is not possible, take measurements at five uniformly distributed locations across the width product for each package in the sample.

When measuring the thickness, place the sample between the micrometer surfaces and lower the spindle head or probe near, but outside, the area where the measurement will be made. Raise the spindle head or probe a distance of 0.008 mm to 0.01 mm (0.000 3 in to 0.000 4 in) and move the sheet to the measurement position. Drop the spindle head onto the test area of the sheet.

Read the dial thickness two seconds or more after the drop, or when the dial hand or digital readout becomes stationary. This procedure minimizes small errors that may occur when the spindle head or probe is lowered slowly onto the test area.

For succeeding measurements, raise the spindle head 0.008 mm to 0.01 mm (0.000 3 in to 0.000 4 in) above the rest position on the test surface, move to the next measurement location, and drop the spindle head onto the test area. Do not raise the spindle head more than 0.01 mm (0.000 4 in) above its rest position on the test area. Take measurements at least 6 mm (¼ in) or more from the edge of the sheet.

- Repeat step 6 above on the remaining packages in the sample and record all thickness measurements. Compute and record the average thickness for the individual package and apply the following MAV requirements.

Evaluation of Results – Individual Thickness

- No measured thickness of polyethylene labeled 25 µm (1 mil) or greater should be less than 80 % of the labeled thickness.

- No measured thickness of polyethylene labeled less than 25 µm (1 mil) should be less than 65 % of the labeled thickness.

Count the number of values that are smaller than specified MAVs (0.8 x labeled thickness if 25 µm [1 mil] or greater or 0.65 x labeled thickness, if less than 25 µm [1 mil]). If the number of values that fail to meet the thickness requirement exceeds the number of MAVs permitted for the sample size, the lot fails to conform to requirements. No further testing of the lot is necessary. If the number of MAVs for thickness measurements is less than or equal to the number permitted for the sample size, go on to Evaluation of Results – Average Thickness.

Evaluation of Results – Average Thickness

The average thickness for any single package should be at least 96 % of the labeled thickness. This is an MAV of 4 %. Circle and count the number of package average thickness values that are smaller than 0.96 x labeled thickness. If the number of package average thicknesses circled exceeds the number of MAVs permitted for the sample size, the lot fails to conform to requirements. No further testing of the lot is necessary. If the number of MAVs for package average thickness is less than or equal to the number of MAVs permitted for the sample size, proceed to Section 2.3. "Basic Test Procedure – Evaluating Results" to determine if the lot meets the package requirements for average thickness.

4.8. Packages Labeled by Linear or Square (Area) Measure

Equipment

- Use a scale that meets the requirements in Section 2.2. "Measurement Standards and Test Equipment." Calculate the length or area of packaged product corresponding to $^{MAV}/6$. If there is no suitable weighing device, all of the packages in the sample must be opened and measured.

- Steel tapes and rules – determine measurements of length to the nearest division of the appropriate tape or rule.

  - Metric Units:

    For labeled dimensions 40 cm or less, Linear Measure: 30 cm in length, 1 mm divisions; or a 1 m rule with 0.1 mm divisions, overall length tolerance of 0.4 mm.

    For labeled dimensions greater than 40 cm, 30 m tape with 1 mm divisions.

- Inch-pound Units:

  For labeled dimensions 25 in or less, use a 36 in rule with $^1/_{64}$ in or $^1/_{100}$ in divisions and an overall length tolerance of $^1/_{64}$ in.

  For dimensions greater than 25 in, use a 100 ft tape with $^1/_{16}$ in divisions and an overall length tolerance of 0.1 in.

- T-square

Test Procedure

1. Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following test procedure to determine lot compliance.

2. Select an initial tare sample according to Section 2.3. "Basic Test Procedure – Tare Procedures."

3. Gross weigh the first package in the tare sample and record this weight.

4. Determine and record the measurements (to the nearest division of the appropriate tape or rule) of the packaged goods (length, width, area; depending upon which dimensions are declared on the label) and weigh the goods from the first package opened for tare determination.

   - Calculate and record the weight of the labeled measurements using the following formula:

     Weight of the labeled measurement =
     (labeled measurement) x (contents weight) ÷ (contents measurement)

   - Look up and record the MAV in units of length or area measure (given in Appendix A, Table 2-8. "Maximum Allowable Variations for Packages Labeled by Length, (Width) or Area"

   Note: See Appendix A, Table 2-10. "Exceptions to the MAVs for Textiles, and Polyethylene Sheeting and Film.

5. Determine and record the tare weight of the first package opened.

6. Determine and record the measurements (length, width, area; depending upon which dimensions are declared on the label) of the product in the second package chosen for tare determination (to the nearest division of the appropriate tape or rule). Determine and record the tare weight of this package.

7. Calculate and record the weight of the labeled measurement for the second package using the following formula:

   Weight of the labeled measurement =
   (labeled measurement) x (contents weight ÷ contents measurement)

The weights of the labeled measurement for two packages must not differ by more than one division on the scale. If they do, open all packages in the sample, measure individually, and compare them against the labeled measure to determine the package errors. If the criterion is met, go to step 8.

8. Calculate the average weight of the labeled measurement and record.

9. Determine and record the average tare weight according to Section 2.3. "Basic Test Procedure – Tare Procedures."

10. Compute and record the nominal gross weight by adding the average weight of the labeled measurements to the average tare weight.

11. Compute package errors according to the following formula:

Package error (weight) = (actual package gross weight) - (nominal gross weight)

12. Convert the MAV to units of weight using the following formula:

MAV (weight) = (avg. wt. of label measurements x MAV [length]) ÷ (labeled measurements)

Convert the MAV to dimensionless units by dividing the MAV (weight) by the unit of measure and record.

Evaluation of Results

Follow the procedure in Section 2.3. "Basic Test Procedure – Evaluating Results" to determine lot conformance.

Convert back to dimensions when completing the report form using following the formula:

Avg. Pkg. Error (dimension) = (Avg. Pkg. Error [dimensionless units]) x (Unit of Measure) x (Labeled unit of measure) ÷ (Avg. Weight of Labeled dimension)

4.9. Baler Twine – Test Procedure for Length

Equipment

- A scale that meets the requirements in Section 2.2. "Measurement Standards and Test Equipment," except a scale with 0.1 g (0.000 2 lb) increments must be used for weighing twine samples. The recommended minimum load for weighing samples is 20 divisions.

- Steel tapes and rules – Determine measurements of length to the nearest division of the appropriate tape or rule.

  - Metric Units:

    For labeled dimensions 40 cm or less, Linear Measure: 30 cm in length, 1 mm divisions; or a 1 m rule with 0.1 mm divisions, overall length tolerance of 0.4 mm.

    For labeled dimensions greater than 40 cm, 30 m tape with 1 mm divisions.

- Inch-pound Units:

  For labeled dimensions 25 in or less, use a 36 in rule with $^{1}/_{64}$ in or $^{1}/_{100}$ in divisions and an overall length tolerance of $^{1}/_{64}$ in.

  For dimensions greater than 25 in, use a 100 ft tape with $^{1}/_{16}$ in divisions and an overall length tolerance of 0.1 in.

- A hand-held straight-face spring scale of at least 4.53 kg (10 lb) capacity or a cordage-testing device that applies the specified tension to the twine being measured. When measuring twine samples or total roll length, apply 4.53 kg (10 lb) of tension to the twine.

Test Procedure

Follow Section 2.3. "Basic Test Procedure – Define the Inspection Lot." Use a "Category A" sampling plan in the inspection; select a random sample; then use the following test procedure to determine lot compliance.

1. Select packages for tare samples. Determine gross weights of the initial tare sample and record. Open the tare samples. Use the procedures for tare determination in Section 2.3. "Basic Test Procedure – Tare Procedures" to compute the average tare weight and record this value.

2. Procedure for obtaining twine samples: randomly select four balls of twine from the packages that were opened for tare.

   From each of the four balls of twine:

   - Measure and discard the first 10.05 m (33 ft) of twine from each roll. Accurate measurement requires applying tension to the ends of the twine before measuring in order to straighten the product.

   - Take two 30.48 m (100 ft) lengths of twine from inside each roll.

   - Weigh and record the weight of each piece separately and record the values. Compare the weight values to determine the variability of the samples. If the individual weights of the eight twine samples vary by more than one division on the scale, use one of the following steps: If the lot is short, determine the actual length of the lightest-weight roll found in the lightest-weight package of the lot to confirm that the weight shortages reflect the shortages in the length of the rolls; or, determine the average weight-per-unit of measure by taking ten 30.48 m (100 ft) lengths from inside the lightest weight package. Use this value to recalculate its length and determine lot compliance.

3. Weigh all of the sample lengths together and record the total value. Determine the total length of the samples (243.8 m or 800 ft, unless more than eight sample-lengths were taken) and record the value. Compute the average weight-per-unit-of-length by dividing the total weight by the total length of the pieces.

4. Determine the MAV for a package of twine (refer to Appendix A, Table 2-8. "Maximum Allowable Variations for Packages Labeled by Length, Width, or Area").

   - Record the total declared package length.

- Multiply the MAV from Appendix A, Table 2-8. “Maximum Allowable Variations for Packages Labeled by Length, (Width), or Area,” times the total package length to obtain the MAV for length and record this value.

- Multiply the weight per unit of length (from step 3) times the MAV for the total declared package length to obtain the MAV by weight and record this value.

- Convert the MAV to dimensionless units and record.

5. Calculate the nominal gross weight and record.

   Follow Section 2.3. “Basic Test Procedure – Determine Nominal Gross Weight and Package Errors for Sample Tare” to determine individual package errors. Determine errors using the following formula:

   Package error (weight) = (package gross weight**)** **-** (nominal gross weight)

- To convert the Package error in weight back to length, divide the weight by the average weight-per-unit-of-length.

Evaluation of Results

Follow the procedures in Section 2.3. “Basic Test Procedure – Evaluating Results” to determine lot compliance.

4.10 Procedure for Checking the Area Measurement of Chamois

Chamois is natural leather made from skins of sheep and lambs that have been oil-tanned. Chamois are irregularly shaped, which makes area measurement difficult. Because of these characteristics, an accurate area determination can only be made using an internationally recognized method of conditioning (rehydrating) and measurement. Chamois is produced in a wet manufacturing process, so it has high moisture content at time of measurement. Chamois is hydroscopic; therefore, its dimensions and total area change as it loses or absorbs moisture. It is also subject to wrinkling. Because of the variation of the thickness and density, and therefore the weight per unit area of chamois, an estimated gross weight procedure cannot be used to verify the labeled area declaration.

Standard Test Conditions: As with all hydroscopic products, reasonable variations in measure must be allowed if caused by ordinary and customary exposure to atmospheric conditions that normally occur in good distribution practice. Both federal and international standards specify procedures to restore the moisture content of chamois so that tests to verify dimensions and area can be conducted.

Federal Test Method Standard 311, “Leather, Methods of Sampling and Testing,” (January 15, 1969) defines the standard atmospheric condition for chamois as 50 ± 4 % relative humidity and 23 ± 2 °C (73.4 ± 3.6 °F). The chamois is considered to be at equilibrium moisture when the difference in two successive weighings, made at 1 hr intervals, is no greater than 0.25 % (e.g., the maximum change in weight on a 100 g sample in two successive weighings is less than 0.25 g (250 mg).

Test Procedures

The area of chamois is verified using a two-stage test procedure. The first stage is a field audit using the template test procedure. This test is used for field audits because it is simpler to perform and does not require the chamois to be conditioned. The field audit is used to identify chamois that are potentially under measure. It is not as accurate as the gravimetric procedure because some error results from reading the area from the template. The gravimetric procedure should be used for compliance testing because it includes conditioning (rehydrating) the chamois.

Template Test Method (for field audits)

Select a random sample of chamois and use the Template Procedure (below) to determine the area of each sample. Chamois is labeled in uniform sizes in terms of square decimeters and square feet, and are sized in increments of ¼ ft^2 (e.g., 1 ft^2, 1¼ ft^2, and 1½ ft^2). Separate the chamois into different sizes and define the inspection lot by specific sizes.

Equipment

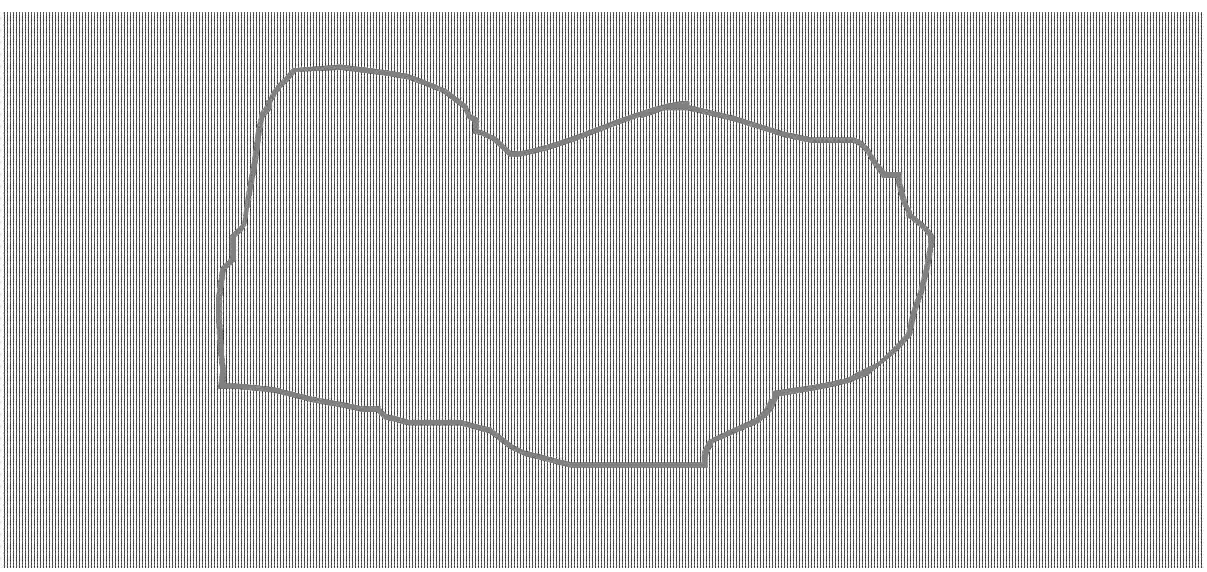
Use a transparent, flexible template that is graduated in square centimeters or square inches and that has been verified for accuracy. The template must be large enough to completely cover the chamois under test.

Template Procedures

1. Template Procedure

   Place the template over the chamois specimen on a smooth surface. Determine the area by counting the number of squares that cover the surface of the chamois. Estimate parts of the template that do not completely cover the chamois by adding the number of partially covered blocks. (See Figure 1.) Compute the total area and go to Evaluation to determine if further action is necessary.

Figure 1.



First Stage – Decision Criteria

If the average minus error exceeds 3 % of the labeled area, the chamois may not be labeled accurately. To confirm the finding, the sample must be taken to a laboratory for conditioning and testing using the gravimetric test procedure.

2. Gravimetric Procedure for Area Measurement

This test cannot be performed in the field because the samples must be conditioned with water before testing. This method is intended for use in checking full or cut skins, or pattern shapes. Open and condition all of the packages in the sample before determining their area on the recommended paper. Conditioning and verifying chamois can be accomplished without destroying the product. When successful tests are completed, the chamois may be repackaged for sale, so do not destroy the packaging material.

Equipment

- Scale with a capacity of 1 kg that is accurate to at least ± 0.01 g and a load-receiving element of adequate size to properly hold the chamois
- Atomizer or trigger-type sprayer and sealable, airtight polyethylene bags
- Medium weight drawing paper (e.g., drawing paper, medium weight (100 lb), regular surface or comparable)
- Household iron with low temperature settings 30 °C to 40 °C (86 °F to 104 °F)
- Rule or tape that is graduated in centimeters or inches
- Instrument for cutting paper (razor blade, scissors, or cutting board)

Sample Conditioning

1. Remove each sample from its packages weigh and record each weight. Using an atomizer-type sprayer, spray water in the amount of 25 % of the weight of each skin uniformly over its area. Place wetted chamois in an airtight polyethylene bag; seal the bag, and leave it in this condition at room temperature for 24 hours.

2. Open the bag, remove the chamois, and reweigh the chamois to confirm that it retained maximum moisture. This is done by confirming that the difference in the two consecutive weighings conducted an hour apart does not exceed 0.25 %).

3. Place the chamois flat on a continuous piece of drawing paper. To remove wrinkles and make the chamois lie flat, use a normal domestic iron that is heated to a maximum of 30 °C to 40 °C (86 °F to 104 °F). Place the iron on the bottom of the skin, and iron the skin up the center to the top. Then, iron the skin from the center out to each side. Iron until the skin is fully extended and perfectly flat.

Measurement

1. Immediately after ironing, carefully draw around the outline of the skin on the paper. Remove the skin; carefully cut along the outline of the skin; weigh the cutout pattern, and record to the nearest 0.1 gas Sample Weight 1 (W1).

2. Lay out the pattern and cut an accurately measured rectangle of a size not less than one-half the area of the pattern. Weigh the cutout rectangle and record the weight to the nearest 0.1 g as Sample Weight 2 (W2). Calculate the area of the rectangle cut from the patterns by multiplying length by width and record as Area (A) in centimeters or square inches.

   - For metric units – calculate the area of the original skin being checked as follows:

$$W1/W2 \text{ x } A = \text{Skin Area in cm}^2/100 = \text{Area in dm}^2$$

   - For inch-pound units – calculate the area of the original skin being checked as follows:

$$W1/W2 \text{ x } A = \text{Skin Area in in}^2/144 = \text{Area ft}^2$$

Evaluation of Results

Compute the average error for the sample and follow the procedures in Section 2.3. “Basic Test Procedure – Evaluating Results” to determine lot conformance.

The MAV for area declarations on chamois is 3 % of the labeled area as specified in Appendix A, Table 2-8. “Maximum Allowable Variations for Packages Labeled by Length, (Width), or Area”.

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Addendum #3

gd 17 jan 09 (0117 S&T Committee 2009)

ILLUSTRATIVE EXAMPLES OF INADEQUATE TEST DRAFT CONCERNS, Re: UTILITY-TYPE WATER METER ACCURACY AND REPEATABILITY

--based on PD meter tolerances (similar results if multi-jet tolerances used)

--comments relate to good meter, when reading resolution limits result in too-large errors in test

--meter reading resolution is, at best, 1/3 graduation of proving indicator at start OF DRAFT, 1/3 graduation at end

--5/8" meter has 10 gallons / 1 cubic foot per proving indicator revolution, 100 graduations

--1-1/2" meter has 100 gallons / 10 cubic feet per proving indicator revolution, with 100 graduation

Meter size	Flow rate, gpm	Test draft	Meter reading resolution, % vs. draft	Concerns for standard accuracy test (tolerance limits +1.5% / -5.0% for min flow, + / - 1.5% for intermediate flow)	Concerns for repeatability test limits (1.3% range for min flow, 0.60% for intermediate flow)	General comments
5/8"	1/4	5 gallon	1.33%	may fail if meter accy curve not well-centered within tolerance limits	reading uncertainty consumes entire tol range -- high probability of failing	min flow, current HB 44 draft
5/8"	1/4	1 ft^3	0.67%	unlikely to fail due to reading resolution limits	reading uncertainty consumes half of tol range -- low-to-moderate probability of failing	min flow, current HB 44 draft
5/8"	1/4	10 gallon	0.67%	unlikely to fail due to reading resolution limits	reading uncertainty consumes half of tol range -- low-to-moderate probability of failing	proposed draft for accuracy tests, and 1-13-09 attempt to at least reduce repeatability test problems
5/8"	2	10 gallon	0.67%	may fail if meter accy curve not well-centered within tolerance limits	reading uncertainty consumes entire tol range -- high probability of failing	intermed flow, current HB 44 draft
5/8"	2	1 ft^3	0.67%	may fail if meter accy curve not well-centered within tolerance limits	reading uncertainty consumes entire tol range -- high probability of failing	intermed flow, current HB 44 draft
5/8"	2	20 gallon	0.33%	unlikely to fail due to reading resolution limits	reading uncertainty consumes half of tol range -- low-to-moderate probability of failing	1-13-09 attempt to at least reduce repeatability test problems
5/8"	2	2 ft^3	0.33%	unlikely to fail due to reading resolution limits	reading uncertainty consumes half of tol range -- low-to-moderate probability of failing	1-13-09 attempt to at least reduce repeatability test problems
1-1/2	1-1/2	10 gallon	6.67%	reading uncertainty consumes entire tol range -- high probability of failing	reading uncertainty four times entire tol range -- high probability of failing	min flow, current HB 44 draft
1-1/2	1-1/2	1 ft^3	6.67%	reading uncertainty consumes entire tol range -- high probability of failing	reading uncertainty four times entire tol range -- high probability of failing	min flow, current HB 44 draft
1-1/2	1-1/2	100 gallon	0.67%	unlikely to fail due to reading resolution limits	reading uncertainty consumes half of tol range -- low-to-moderate probability of failing	proposed draft for accuracy tests, and 1-13-09 attempt to at least reduce repeatability test problems
1-1/2	1-1/2	10 ft^3	0.67%	unlikely to fail due to reading resolution limits	reading uncertainty consumes half of tol range -- low-to-moderate probability of failing	proposed draft for accuracy tests, and 1-13-09 attempt to at least reduce repeatability test problems

(continued on next page)

ILLUSTRATIVE EXAMPLES OF INADEQUATE TEST DRAFT CONCERNS, Re: UTILITY-TYPE WATER METER ACCURACY AND REPEATABILITY (continued)

Meter size	Flow rate, gpm	Test draft	Meter reading resolution, % vs. draft	Concerns for standard accuracy test (tolerance limits +1.5% / -5.0% for min flow, + / - 1.5% for intermediate flow)	Concerns for repeatability test limits (1.3% range for min flow, 0.60% for intermediate flow)	General comments
1-1/2"	8	50 gallon	1.33%	reading uncertainty almost half of tol range -- high probability of failing	reading uncertainty two times entire tol range -- high probability of failing	intermed flow, current HB 44 draft
1-1/2"	8	5 ft^3	1.33%	reading uncertainty almost half of tol range -- high probability of failing	reading uncertainty two times entire tol range -- high probability of failing	intermed flow, current HB 44 draft
1-1/2"	8	100 gallon	0.67%	may fail if meter accy curve not well-centered within tolerance limits	reading uncertainty consumes entire tol range -- high probability of failing	proposed draft for accuracy test improvements
1-1/2"	8	10 ft^3	0.67%	may fail if meter accy curve not well-centered within tolerance limits	reading uncertainty consumes entire tol range -- high probability of failing	proposed draft for accuracy test improvements
1-1/2"	8	200 gallon	0.33%	unlikely to fail due to reading resolution limits	reading uncertainty consumes half of tol range -- low-to-moderate probability of failing	1-13-09 attempt to at least reduce repeatability test problems
1-1/2"	8	20 ft^3	0.33%	unlikely to fail due to reading resolution limits	reading uncertainty consumes half of tol range -- low-to-moderate probability of failing	1-13-09 attempt to at least reduce repeatability test problems

From: Kristin Macey
Sent: Monday, February 23, 2009 8:31 AM
To: Dan Reiswig; John Roach
Cc: Ken Lake
Subject: FW: Handbook 44, Section 3.36 Proposed Changes - Additional Support

Importance: High

Attachments: NCWM ST Committee 2009 A4.pdf; HB 44 Feb 2009 Manu C Data.pdf
FYI, more to answer.

From: Noel, Andre [mailto:anoel@neptunetg.com]
Sent: Monday, February 23, 2009 6:22 AM
To: lucas@agri.ohio.gov; Ed Williams; Kristin Macey; tina.butcher@nist.gov
Cc: Roncoke@aol.com; gdejarlais@badgermeter.com; Scott.Swanson@Sensus.Com; alex.watson@us.elster.com
Subject: Handbook 44, Section 3.36 Proposed Changes - Additional Support
Importance: High

Dear Mr. Todd Lucas and Mr. Ed Williams.

We respectfully submit to you additional support to our letter dated February 12, 2009 for your consideration and approval.

Please feel free to contact any of the undersigned should you have any questions.

We look forward to hearing from you.

Yours truly,
Scott Swanson - Sensus Metering System Tel: (724) 430-4059
George DeJarlais - Badger Meter, Inc Tel: (414) 371-5754
Andre Noel - Neptune Technology Group Inc Tel: (334) 283-7298
Alex Watson - Elster AMCO Water Tel: (352) 368-4652
Ron Koch - Master Meter, Inc Tel: (412) 847-2097

File Identification: HB 44 Feb 2009 Manu C Data

23 February 2009 Addendum #4

-- fails to meet HB 44 requirements (red)

-- only marginally passes HB 44 requirements (yellow)

Handbook 44, Section 3.36 Water Meters -- Accuracy/Repeatablity Testing at Various Test Drafts

Sheet 1: Testing of 5/8 x 3/4 Positive Displacement Meters

A. Testing with Gallon Registration

1. Tests at Intermediate Flow Rate of 2 GPM

	Accuracy, 40 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	**100.22**	**100.22**	**100.37**	100.27	0.15
G2	**100.37**	**100.30**	**100.12**	100.26	0.25
G3	**100.32**	**100.30**	**100.37**	100.33	0.07
G4	**100.55**	**100.35**	**100.14**	100.35	0.40
G5	**100.40**	**100.40**	**100.32**	100.37	0.08

	Accuracy, 20 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	**100.22**	**100.35**	**99.69**	100.09	0.66
G2	**100.17**	**100.06**	**100.81**	100.35	0.76
G3	**100.52**	**100.45**	**100.30**	100.43	0.23
G4	**100.17**	**100.26**	**100.72**	100.38	0.54
G5	**100.27**	**100.35**	**100.30**	100.31	0.08

	Accuracy, 10 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	**100.71**	**100.09**	**100.25**	100.35	0.62
G2	**99.72**	**100.49**	**99.95**	100.05	0.78
G3	**100.91**	**100.39**	**99.95**	100.42	0.96
G4	**100.51**	**100.49**	**100.35**	100.45	0.16
G5	**100.31**	**100.39**	**99.76**	100.15	0.64

2. Tests at Minimum Flow rate of 0.25 GPM

	Accuracy, 20 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	**99.70**	**99.71**	**99.59**	99.67	0.13
G2	**100.30**	**100.01**	**99.82**	100.04	0.47
G3	**99.25**	**99.32**	**99.17**	99.24	0.15
G4	**99.90**	**99.57**	**99.68**	99.71	0.33
G5	**99.75**	**99.71**	**99.87**	99.78	0.16

	Accuracy, 10 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	**99.63**	**99.42**	**99.73**	99.60	0.31
G2	**99.43**	**99.52**	**99.54**	99.50	0.11
G3	**99.03**	**98.92**	**99.14**	99.03	0.22
G4	**98.93**	**99.12**	**99.34**	99.13	0.41
G5	**99.53**	**99.62**	**99.05**	99.40	0.57

	Accuracy, 5 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	**97.89**	**96.28**	**98.50**	97.55	2.22
G2	**99.88**	**100.87**	**99.70**	100.15	1.17
G3	**100.88**	**100.87**	**98.50**	100.08	2.38
G4	**101.47**	**101.47**	**99.70**	100.88	1.78
G5	**99.88**	**96.48**	**98.50**	98.28	3.40

B. Testing with Cubic Foot Registration

1. Tests at Intermediate Flow Rate of 2 GPM

	Accuracy, 4 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	**100.61**	**100.57**	**100.48**	100.55	0.12
F2	**100.56**	**100.62**	**100.44**	100.54	0.18
F3	**100.61**	**100.55**	**100.39**	100.51	0.22
F4	**100.33**	**100.50**	**100.44**	100.42	0.16
F5	**100.41**	**100.67**	**100.48**	100.52	0.26

	Accuracy, 2 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	**100.37**	**100.22**	**100.69**	100.43	0.47
F2	**100.57**	**100.32**	**100.39**	100.43	0.25
F3	**100.62**	**100.27**	**100.44**	100.45	0.35
F4	**100.47**	**100.47**	**100.34**	100.43	0.13
F5	**100.32**	**100.62**	**100.59**	100.51	0.30

	Accuracy, 1 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	**101.29**	**101.20**	**100.47**	100.99	0.83
F2	**99.55**	**100.83**	**101.39**	100.59	1.84
F3	**100.10**	**100.83**	**101.39**	100.77	1.29
F4	**99.91**	**100.28**	**100.93**	100.37	1.01
F5	**100.19**	**100.10**	**100.74**	100.34	0.64

2. Tests at Minimum Flow rate of 0.25 GPM

	Accuracy, 2 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	**99.99**	**100.13**	**99.73**	99.95	0.39
F2	**99.74**	**99.68**	**99.68**	99.70	0.06
F3	**98.99**	**98.88**	**98.70**	98.86	0.29
F4	**99.84**	**99.88**	**100.08**	99.93	0.24
F5	**99.54**	**99.88**	**99.24**	99.55	0.64

	Accuracy, 1 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	**99.89**	**99.79**	**99.85**	99.84	0.10
F2	**100.09**	**99.51**	**99.55**	99.72	0.58
F3	**98.90**	**99.32**	**99.35**	99.19	0.45
F4	**100.09**	**99.69**	**99.45**	99.75	0.64
F5	**99.39**	**99.42**	**99.15**	99.32	0.26

	Accuracy, 0.5 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	**98.15**	**99.74**	**101.45**	99.78	3.31
F2	**100.74**	**102.13**	**101.45**	101.44	1.39
F3	**100.34**	**101.13**	**99.06**	100.18	2.08
F4	**101.53**	**100.93**	**100.53**	101.00	1.00
F5	**101.93**	**102.13**	**101.45**	101.84	0.68

Date: 23 February 2009

To: Todd Lucas, Chair, NCWM S&T Committee, and Ed Williams, Director, California DFA, Division of Measurement Standards

CC: Tina Butcher, NIST, and Kristin Macey, CDFA

From: Joint letter from five water meter manufacturers

Subject: Addendum 4 (New Test Data)

Re: Handbook 44, Section 3.36 Proposed Changes

Dear Todd and Ed:

In support of our of our 12 February letter to you, please find attached an Excel spreadsheet labeled as Addendum 4. As discussed with Kristin Macey on 14 January, the manufacturers have begun additional testing, expanding upon the test data that has already been provided to the National S&T Committee. At this time, one manufacturer's testing has progressed to the point that the full test format has been completed, at least for one group of 5/8 x ¾ positive displacement meters covering both gallon and cubic feet registration. Observations and comments on this latest data:

1. 5 Gallon (or 0.5 Cubic Foot) Drafts at 0.25 GPM: The minimum flow rate test with a 0.5 cubic foot draft uses only half of the current HB 44 draft. This was performed in conjunction with the analogous minimum flow rate test with a 5 gallon draft (which **is** the current HB 44 draft size). Both drafts result in only ½ revolution of the proving indicator (i.e., providing only 50 graduations for indicated through-put), causing unacceptable test uncertainties and unreliable results:

A: Seven of ten meters fail to meet the HB 44 range of 1.3% for repeatability.

B: Four of 30 individual accuracy tests fail to meet the HB 44 limits of + 1.5% / -5.0%, with an additional five individual accuracy tests that only marginally meet the HB 44 limits.

When the 0.25 gpm test drafts are increased to 10 gallons or 1 cubic feet**, (the compromise position discussed on the afternoon of 13 January**) there are no failures for accuracy or for repeatability. For individual meters, there are also some significant changes (2% or more) in the three-test average accuracy results. This clearly shows the inadequacies when only ½ revolution, rather than one full revolution, of the proving indicator is used.

When the 0.25 gpm test drafts are further increased to 20 gallons or 2 cubic feet, there are no significant changes in the average accuracies for individual meters, and a slight improvement in the average for all the repeatability ranges.

2. 10 Gallon or 1 Cubic Foot Drafts at 2.0 GPM: The intermediate flow rate tests with 10 gallon or 1 cubic foot drafts are the current HB 44 requirements. Both drafts result in only one revolution of the proving indicator (i.e., providing only 100 graduations for indicated through-put). Since the tolerance ranges at intermediate flow are only 46% as large as those for the minimum flow rate tests, these intermediate rate draft sizes also cause unacceptable test uncertainties and unreliable results:

A: Nine of ten meters fail to meet the HB 44 range of 0.6% for repeatability.

B: Two of 30 individual accuracy tests only marginally meet the HB 44 limits of + 1.5% / - 1.5%.

When the 2 gpm test drafts are increased to 20 gallons or 2 cubic feet **(the compromise position discussed on the afternoon of 13 January)**, there are no longer any 'marginal' accuracy results, and only two of ten meters fail for repeatability. For some individual meters, there are moderate changes in the three-test average accuracy results.

When the 2 gpm test drafts are increased to 40 gallons or 4 cubic feet (our original September 2008 proposal for repeatability testing only), there are no longer any failures for repeatability. Only minor changes are seen in the three-test average accuracies for individual meters

While this new test data is somewhat more extensive, it is entirely consistent with earlier data supplied to the committee by the individual water meter manufacturers. We have seen <u>no</u> conflicting test data showing that current test drafts <u>do not</u> result in unacceptable meter reading uncertainties, and feel confident that if the California DMS (or other California jurisdictions) were to perform the <u>same test program that is detailed on our attached Addendum</u>, they would see similar results. Such testing may seem superfluous, of course, given the known reading resolution limits for the meters being used in the submetering market and the resultant test uncertainty calculations. The attached test data combined with the previously supplied data can only solidify our position and provide further irrefutable evidence to support our proposals.

Therefore it is the position of the water meter manufacturers that we have far exceeded the normal requirements to support CDFA and the S&T Committee's requests for data without any data or comments that refutes our position, and as such we respectfully request that the compromise positions reached on January 14th by the S&T committee or the original proposals be re-instated as voting items for the NCWM Annual Meeting.

We look forward to hearing from you by Monday, March 2, 2009.

Yours truly,

Scott Swanson - Sensus Metering System Tel: (724) 430-4059

George DeJarlais - Badger Meter, Inc Tel: (414) 371-5754

Andre Noel - Neptune Technology Group Inc Tel: (334) 283-7298

Alex Watson - Elster AMCO Water Tel: (352) 368-4652

Ron Koch - Master Meter, Inc Tel: (412) 847-2097

Attachment: Addendum #4 (Excel Spreadsheet)

Date: 12 February, 2009

To: Todd Lucas, Chair, NCWM S&T Committee, and Ed Williams, Director, California DFA, Division of Measurement Standards)

CC: Tina Butcher (NIST) and Kristin Macey (CDFA)

From: Joint Letter from Five Water Meter Manufacturers

Subject: Handbook 44, Section 3.36 Proposed Changes

Dear Todd and Ed:

We would like to thank the National S&T Committee, for the considerations given to our three proposed changes to the water meter code during the work sessions on 13-14 January in Daytona Beach. And we would like to thank the California DMS for hosting the April 2008 meeting at which manufacturers were able to formulate these proposals with the assistance of state and county stakeholders.

However, we would like to make an additional appeal for the committee to take further action over the next few months, in order to rectify the current provisions of Handbook 44 (HB44), Section 3.36. We are hoping that there is some committee mechanism that can be pursued prior to the July 2009 annual meeting, perhaps short of the submission of "priority" items based upon the economic health of water meter manufacturers and of other participants in the submetering industry.

The reason for this position is based on the actions unknowingly taken by California DMS through the NCWM on January 14th to:

1. Effectively prohibit water manufacturers from obtaining CTEP approvals for submetering applications.

Under the current Handbook 44 requirements a water meter manufacturer has less than a 30% probability of passing the CTEP repeatability requirement for registration in gallons.

Since this repeatability requirement was added to Section 3.36, several submittals to California's DMS type evaluation testing have failed in repeatability tests resulting in manufacturers indefinitely postponing new type evaluation submittals until these test drafts can be corrected.

2. Disregard the standards of the American Water Works Association (AWWA), the supported proposals of the Water Meter Manufacturers and the requirements of the submetering industry.

Our proposals were formulated after reviewing AWWA meter standards, common meter designs, test practices and general HB 44 requirements with California DMS during meetings held in April of 2008. Subsequently, no objections were raised by the California DMS to our repeatability test proposal until the open hearings on January 13, 2009 (and, in fact, the California stakeholders had voted in favor our repeatability test proposal at the September WWMA meeting). For our standard accuracy test concerns, California stakeholders provided no input and raised no objections between April and September of 2008, until relegating our proposal to developing item status at the WWMA annual meeting (at that point, calling for supporting test data which we have since provided). During discussions with CWMA, SWMA and NEWMA in the fall of 2008, we explained our proposed changes (along with the technical reasons for these changes), and received no negative feedback.

3. Restrict access to the submetering industry by any Water Meter Manufacturer, by rejecting good meters. In addition there is the risk of accepting bad meters.

For meters smaller than 1-1/2”, there is an inequity in the minimum flow test draft sizes, with cubic foot testing resulting one full revolution of the proving indicator, while gallon testing results in only one-half revolution of the proving indicator. For standard accuracy testing (as opposed to the more restrictive repeatability testing), these too-small test drafts lead to unacceptable test uncertainties, and can result in both the erroneous rejection of good meters and the erroneous acceptance of bad meters.

4. Reject industry test data.

Water meter manufacturers proposed test drafts for standard accuracy tests were reviewed at length with county and state stakeholders during our April 2008 meeting in Sacramento. We were surprised that some California jurisdictions voted at the WWMA meeting that this remain a developing item until supporting test data were provided. However, as requested by the WWMA S&T Committee, we provided <u>significant test data</u> in support the proposal over the subsequent few months. California jurisdictions, on the other hand, <u>did not supply any further data</u> (beyond the Los Angeles County data given to the WWMA S&T Committee **that actually supports the manufacturers proposal as to insufficient draft sizes**). The test data we provided has not to-date, been used by either the regional or national committees to advance this proposal to a voting item, particularly in the absence of any other data that would contradict our meter reading resolution concerns.

5. Present a defacto restraint of trade.

Without corrections, utility-type water meters larger than 1” are <u>guaranteed to fail</u> in HB44 testing.

Summary

Throughout 2008, the water meter manufacturers have worked diligently with you and the regional associations to raise the awareness and receive the support of our proposals to lift the barriers impairing water meter manufacturers from serving the submetering industry. Unfortunately for all of our efforts we have failed the industry; therefore we are looking for your assistance in providing us with recommendations on the actions we can pursue jointly in an effort to allow your consideration of the compromise positions discussed during the committee work session on the afternoon of 13 January. As part of this effort, we are more that willing to work with the California jurisdictions to generate additional supporting data, particularly if the committee deems this necessary for their deliberations and the reinstatement of the proposals, however please note that the water meter manufacturers have already supplied a great deal of test data that fully supports these proposals. After further review we are hoping that the committee is already in a position to make a decision on these proposals. Although this action was unintentional, it has caused severe economic pain to the submetering industry.

We do trust that you will afford us your ability to assist us in bringing this matter to a better conclusion

We look forward to hearing from you by Monday, March 2, 2009.

Yours truly,

Scott Swanson - Sensus Metering System	Tel: (724) 430-4059
George DeJarlais - Badger Meter, Inc	Tel: (414) 371-5754
Andre Noel - Neptune Technology Group Inc	Tel: (334) 283-7298
Alex Watson - Elster AMCO Water	Tel: (352) 368-4652
Ron Koch - Master Meter, Inc	Tel: (412) 847-2097

Attachments: Addendum #1, #2, and #3 (Excel Spreadsheet)

Addendum #1

The attached spreadsheet (Addendum #3) is intended to provide further insight into our various test draft concerns.

Given the new objections raised in Dayton Beach, we are at this time specifically asking that the committee re-instate the compromise positions discussed during the committee work session on the afternoon of 13 January:

a) From Agenda item 360-2, Part 4, Item 1, correct the minimum rate test drafts for utility type water meters, so that they entail one complete revolution of the proving indicator. While this only partially addresses our concerns for test resolution during repeatability testing, it does address our concerns for resolution during simple accuracy tests (and provides harmonization with AWWA M6). Again, this had been placed as a developing item at the WWMA September meeting, until supporting test data could be provided (by the manufacturers and by California jurisdictions) – the manufacturers subsequently provided such test data.

b) In response to Agenda item 336-2 concerns, accept a compromise position by calling for intermediate rate test drafts for utility type water meters to use two complete revolutions of the proving indicator. While this only partially addresses our concerns for test resolution during repeatability testing, it is at least a step in the right direction. Certainly the deficiencies in the current repeatability test drafts have already been recognized, as evidenced by the unanimous favorable vote on this item at the WWMA September meeting.

To review, these two actions would at least address harmonization with AWWA M6, open the market to the sale of 1-1/2 and 2” utility-type meters, remove the inequities between gallon and cubic foot registration for smaller meters, and eliminate excessive test uncertainties for standard verification/re-verification accuracy tests at the minimum rate. There would still be inadequacies in draft sizes for repeatability testing, but this would at least be an incremental improvement in the probability of reliable test results being obtained.

We are more than willing to accept the offer made by Kristin on 14 January, in which she would coordinate the California testing of new sample meters to be submitted by all the manufacturers. We certainly appreciate that California jurisdictions need to understand the attributes of utility type water meters, including their reading resolution, when assessing the suitability of test methods. These sample meters are now being prepared, and could be shipped to Kristin’s attention within the next few weeks. And we hope that NIST (through Tina) can provide any needed technical support as test results are being analyzed. However, we are concerned over the extent of either county or state testing that may be performed. And we are even more concerned that any such testing would not be done in time to support any NCWM action on the above two items in 2009.

Addendum #1 - continued

In contrast, the five manufacturers have already provided significant test data, clearly supporting the need for increased test drafts. In addition, the only California test data provided to the committee, while not addressing repeatability test concerns, did show that increased test drafts improved the absolute values of the indicated errors in 24 out of 28 units, for multijet meters tested at the minimum rate. Coupled with the informational material that the manufacturers prepared for the various regional and national S&T committee meetings in 2008 (and for the meeting with California jurisdictions hosted by Kristin last April), this existing test data should allow your committee to assess the current disconnect between HB 44 test drafts and the meter reading resolutions provided by utility type water meters.

If the committee or the California DMS still believe that additional data is needed, we ask that you work with us to develop this information as quickly as possible, so that action can still be taken this year.

Addendum #2

As background or reference material, we are also providing detailed commentary and history on our proposals as of the committee work sessions at WWMA in September 2008:

A—Agenda item 336-1 (S.1.1.3. Value of Smallest Unit)

> We are pleased to see this item forwarded to the Annual Meeting as a voting item. The current HB 44 text does not address cubic foot registration, and is incorrect with respect to the common utility-type meters in sizes larger than 1". Also, the current text does not fully-define the meter reading indications needed to both test the meter and to generate billing statements. Now that California has seen the first submittals for utility-type meters larger than 1", revisions to this text are certainly necessary. The proposed change includes provisions for these larger meters, as well as addressing the need for 'proving indicator' clarification, using an approach similar to that in the 3.33 gas vapor meter code.
>
> The five interested meter manufacturers certainly appreciate the input provided by California jurisdictions on this item, during our meeting in Sacramento last April. We understand the need to work with these jurisdictions, since these are the only stake-holders within the NCWM community who have any direct experiences or concerns with utility-type water meters.

B—Agenda item 336-2 (336-2 (T.1.1. Repeatability)

> We are gravely disappointed that this item has been withdrawn, after previously being approved as a voting item at the September WWMA meeting. When the current repeatability provisions were added to the water meter code (circa 2001), the meter reading resolution limitations were clearly not understood, since this single aspect of test uncertainly alone can 'consume' the entire tolerance range for repeatability, given the inadequate test drafts given in HB 44. Certainly this exceeds the "one-third rule" for test uncertainties. It can even be argued that for type-evaluation testing, as opposed to simple accuracy test audits, total test uncertainty may need to be held to even tighter standards, such as one-fifth of the total tolerance range.
>
> This test draft inadequacy is particularly evident for meters larger than 1", where the current drafts are insufficient by an order of magnitude or more.
>
> The meter manufacturers have demonstrated these reading resolution limitations, and have explained both the market needs and the AWWA standards provisions that have driven meter designs to these specific reading resolutions. From the calculations that we have provided, it is clear that any passing results for repeatability tests of utility-type meters are merely a matter of luck. [See attached spreadsheet (Addendum #3) for some examples of these test concerns]. In addition, it has been reported that California type evaluation test results have exhibited problems in repeatability. Clearly, this is imposing an economic hardship on manufacturers who fail in their attempts to obtain type evaluation listings for their products (or who are deferring submittals of new products for type evaluations until these repeatability issues are corrected).

B—Agenda item 336-2 (336-2 (T.1.1. Repeatability) - continued

It is unfortunate that the current objections to our repeatability proposal (that test drafts for repeatability tests should be the same as the drafts for standard accuracy tests, and that test data should be generated to support our proposals) were first presented to the manufacturers on 13 January 2009, during the interim meeting's open hearings and the subsequent committee work session. These objections were certainly not raised during our meeting with the California stake-holders last April. Nor were they raised during the September WWMA annual meeting, where all jurisdictions voted in favor of this proposal. Finally, no such objections were discussed with the manufacturers, when we attended the September CWMA interim meeting, the October SWMA annual meeting, and the October NEWMA interim meeting. It can also be argued that the tolerance range for repeatability, being five-fold tighter than the tolerance range for simple accuracy, could easily justify the use of larger test drafts than those needed for simple accuracy tests.

We had welcomed the decision made by your committee on the afternoon of 13 January, in upgrading Item 360-2, Part 4, Item 1 of the agenda to a voting item, in part as a response to the repeatability concerns that had originally prompted us to propose Item 336-2 (see discussion below for further comments on this third agenda item). While such a move would not have addressed repeatability concerns at the intermediate rate, it would have provided partial relief for repeatability problems at the minimum rate. In response to this committee decision, we had suggested that you also consider increasing the test drafts at intermediate flow to two full revolutions of the proving indicator. This would also provide partial relief for repeatability problems, while only adding five minutes of test time during each draft for 5/8" meters (for example).

We were certainly disappointed when your committee then reversed this 13 January decision during your continued work session on 14 January. Some of the 5/8" meter test data already supplied by the manufacturers to the committee (through NIST) clearly demonstrated significant problems with the current repeatability tests, while the current situation for 1-1/2" and 2" meters is so patently incorrect that test data should be a moot point. We had welcomed the proposal made by Kristin Macey on 14 January (that the interested manufacturers provide test meters and test guidance, so that California jurisdictions could then readily perform additional tests that will undoubtedly support of our proposal).

Nevertheless, we are very concerned that our proposal seems to be moving backwards, and that jurisdictions may be presenting us with a 'moving target' as their views on the subject change from one meeting or discussion to the next.

C—Agenda Item 360-2, Part 4, Item 1 (Water Meters: N.3. Test Drafts and N.4. Testing Procedures).

Ultimately, we are very disappointed that this item is only "Informational" at this time, particularly in light of the decision to withdraw our proposed changes for repeatability. This third proposal is based upon harmonizing the minimum flow test drafts with those given in AWWA M-6, entailing test drafts large enough to provide one full revolution of the proving indicator. With current HB 44 test drafts, some tests for meters 1" and smaller provide only one-half revolution of the proving indicator, and this results in meter reading resolution uncertainties alone that would 'consume' roughly one-quarter of the total accuracy test tolerance range – coupled with other test uncertainties or errors, this would certainly violate the "one-third rule". This could result in some good meters being mistakenly rejected for failing in accuracy test, as well as some bad meters being mistakenly accepted. In the case of 1-1/2" and 2" meters, current HB 44 test drafts provide only one-tenth of a revolution of the proving indicator, and valid testing is clearly impossible.

This proposal had been refined during our April meeting with the California jurisdictions. As a result, we were somewhat surprised when Californian stake-holders voted against this at the September WWMA annual meeting. The WWMA regional S&T committee then made this a developing item, until the manufacturers and California jurisdictions could provide sufficient test data to make an informed decision on our proposals. The manufacturers supplied test data to NIST via individual e-mails on 13 September, 18 September, 19 September, 29 September, 8 October, and 17 December, 2008. While the data was to address accuracy test resolution concerns, some of it also demonstrates our repeatability test concerns. ***Aside from the LA County test data supplied at the WWMA meeting (which in fact supports our position), we are not aware of any other data supplied by California jurisdictions.*** During our discussions with the other three regions at their Fall 2008 meetings, the manufacturers received no input on this item (understandable, since we are aware of no jurisdictions outside of California that have any experience or interests in testing utility-type water meters).

During our discussions at Daytona Beach, we commented on the LA County test data for minimum flow test drafts of five gallons and ten gallons -- average accuracy did not change (to be expected with a larger sample size), but nine of 28 went from 'fail' to pass' with the larger test draft, and 24 of 28 showed reduced absolute values for indicated error. Clearly this indicates our contentions that the current test drafts are inadequate. Brett Saum of the S&T committee also pointed-out the inequity in test drafts for meters 1" and smaller – in 'gallon' testing to a five gallon draft, the proving indicator only sees half of a full revolution, while in 'cubic foot' testing to a one cubic foot draft, the proving indicator sees one full revolution [see attached spreadsheet (Addendum #3) for further illustrations of our reading resolution concerns].

D—Proposal Status following the Daytona Beach Meeting

With the withdrawal of Item 336-2, and the "Informational" status of 360-2, Part 4, Item 1, there remains no possibility of using conventional AWWA utility-type 1-1/2" and 2" water meters in submetering applications. More importantly, all utility-type meters are at high risk of failing repeatability testing at intermediate rates, and 'gallon' meters are at high risk of failing repeatability testing at minimum rates. These same 'gallon' meters are at moderate risk of having erroneous test results at the minimum rate, in conventional accuracy tests.

With this in mind, the Elster-AMCO, Neptune and Badger representatives at the Daytona Beach meeting thought that the approach suggested by the S&T committee on 13 January (up-grading the developing item to a voting item) would have been a positive step forward, particularly if our suggested two-fold increase in intermediate rate test drafts was also added. As discussed above, this would have addressed the standard accuracy test concerns (and in doing so, remove an absolute barrier to the use of 1-1/2" and 2" meters, as well as remove the inequity between 'gallon' and 'cubic foot' meters, and harmonize HB 44 minimum rate test drafts with those provided in AWWA M-6). It would also have reduced some of the meter reading resolution limitations to "only" one-half of the total repeatability test tolerance range. This approach would, of course, also address the new concern raised during the open hearings, i.e., that standard accuracy tests and the special repeatability tests use the same test drafts (although the likelihood of local jurisdictions, as opposed to state type evaluation labs, ever doing a full-blown repeatability test must be quite small). Again, see the attached spreadsheet (Addendum #3) for further illustrations of these problems and possible solutions.

March 5, 2009

To: Scott Swanson, Sensus Metering System
George DeJarlais, Badger Meter, Inc.
Andre Noel, Neptune Technology Group, Inc.
Alex Watson, Elster AMCO Water
Ron Koch, Master Meter, Inc.

Subject: Response to Your February 12, 2009 Letter Regarding Proposed Changes to NIST Handbook 44, Section 3.36 Water Meters

Dear Sirs:

The NCWM S&T Committee (Committee) and CDFA received your letter dated February 12, 2009 on the subject of "Handbook 44, Section 3.36 Proposed Changes" in which you raise concerns about the impact of Committee actions on Items relating to water meters. We are continuing to consider the points raised in your letter, during which time state and local weights and measures officials in California are collecting additional data under the supervision of CDFA. In the meantime, we wanted to acknowledge the receipt of your letter; provide you with clarification on the how the status of these items on the S&T Committee's agenda affects their consideration in the NCWM process; and ask for your additional feedback on some additional points.

During the January 2009 Interim Meeting of the National Conference on Weights and Measures, the Committee addressed three agenda items related to water meters. As some of you may recall from the verbal report given by Mr. Lucas during the joint committee session held at the conclusion of the Interim Meeting, the Committee designated each item with a status as indicated adjacent to the item number. Items designated with a "V" are recommended for a vote by NCWM members at the July 2009 Annual Meeting; those designated with a "W" have been withdrawn from the Committee and are typically referred back to the originating regional weights and measures association or technical organization; and those designated with an "I" are to be maintained on the Committee's agenda for further study and review prior to recommending NCWM action.

336-1 V S.1.1.3. Value of Smallest Unit and S.1.1.6. Proving Indicator

336-2 W T.1.1. Repeatability

336-3 I N.3. Test Drafts and N.4. Testing Procedures (this item was previously designated as Developing Item Part 4, Item 1)

We want to take the opportunity to express our appreciation for your time in participating in the Committee's discussion of these issues and in providing comments and supporting data to assist the Committee in its deliberations at the national, state, and regional level. Support of proposed changes in the form of an NCWM affirmative vote is typically achieved only through careful consideration of the issues and their potential impact by all interested parties; thus, these types of interactions, including discussions, written comments, public hearings, and data collection, increase the likelihood that the proposed changes will be accepted by the NCWM membership.

As noted above, we are continuing to consider your comments during the collection of additional data. In the meantime, we offer the following comments on points raised in your letter.

Item 336-2. In Addendum #1 of your letter, you ask that the Committee change decisions it made at the Interim Meeting, urging the Committee to revisit information provided. You have asked in Addendum #1 of your letter that the Committee restore this item and modify it to specify a test draft equal to two revolutions of the proving indicator, noting that such a change will only partially address your concerns. First, the Committee's chief rationale for withdrawing this item is the technical inconsistency in establishing a differing size test draft for normal and special accuracy tests than for repeatability tests. Your proposed change would not eliminate that inconsistency. Even if this were not the case, the Committee is uncomfortable deliberating and deciding upon changes of this significance outside of the open hearing process, particularly when you note that this may not fully solve your concerns; the Committee believes that input on any alternative position warrants a more open discussion by the membership to ensure that views of other stakeholders are adequately considered. Included below is an excerpt from the Committee's Interim Report, outlining the Committee's rationale on its position. You will note that the Committee is not ruling out a consideration of changes in test draft size for repeatability tests nor is it oblivious to the importance of reducing uncertainties in the test process; however, the Committee notes that such changes need to be considered in conjunction with a review of other accuracy test requirements.

The Committee acknowledged the concerns expressed by the water meter manufacturers regarding the importance of selecting an appropriate size test draft as one means of reducing uncertainties in the test process. Based on input from the manufacturers and from some weights and measures officials, the Committee believes there may be merit to linking the test draft size to at least the quantity indicated in one revolution of the dial on a mechanical water meter as a means to reduce uncertainties. However, the Committee believes that, if the current test draft size is contributing a significant uncertainty to the test process, this concern would apply equally to all accuracy tests, not just repeatability tests. The Committee also had remaining questions about how one might define the test draft size relative to the indications on a dial, given the wide variety of indicator types in use in the marketplace.

Because members of the WWMA were not convinced at the WWMA's September 2008 meeting that the contribution of errors from the existing test draft size warranted a change in the test draft size for normal and slow flow tests, the Committee was reluctant to support the proposed change in test draft size for repeatability tests alone. The Committee heard that the California Division of Measurement Standards will be working with jurisdictions in California to collect additional data in conjunction with the Developing Item on normal and special test draft sizes, and this information may provide a better indication of which proposal will be acceptable to the weights and measures community. The Committee also noted that some of the proposed changes to test draft size in this item and in a corresponding Developing Item (Item 360-2, Part 4, Item 1) are larger than current AWWA standards. The Committee believes that the issue of test draft size must be considered jointly for all accuracy tests to ensure consistent application of these principles. Consequently, the Committee withdrew this item from its agenda and suggested that the idea of increased test drafts for repeatability tests be *considered in conjunction with Developing Item 360-2, Part 4, Item 1, Water Meters, N.3. Test Drafts and N.4. Testing Procedures.*

Item 336-3. With regard to what is now Item 336-3, you have asked the Committee to reconsider an alternative discussed during the Committee's work session at the Interim Meeting, and, in your Addendum #2, you expressed disappointment in the item's informational status.

We can appreciate your disappointment that Developing Item part 4, Item was elevated only to an "Information" status rather than a "Voting" status. Please note that, even if the item had been designated a "Voting" item, this does not guarantee acceptance by the NCWM membership. The Committee believed that sufficient data and information along with specific proposed language had been developed for this item to warrant consideration at the national level. However, the Committee was mindful of the following.

- The region submitting this item for inclusion on the Developing Issues agenda (the Western) was unable to attain agreement that the item (as currently presented) is ready to propose for national consideration.

- The alternative discussed at the Interim Meeting was considered a substantial change to the original proposal, and, consequently, this may require additional time for other interested parties to analyze the alternative proposal and to consider any potential impact to the public and regulatory officials.

When there are indications that segments of the voting body are not in support of an item or when an item requires additional work, presenting that item for a vote sets the stage for the item to fail. Once an item fails, it is removed from the Committee's agenda. Additional work and justification would then be required by the original (or a new submitter) and a vote by the regional or technical committee for further action before the item could be further considered by the Committee at the national level. Even if the original submitter acts quickly to supply additional justification, the process can result in delays. Thus, the Committee is particularly cognizant of the negative impact of presenting an item prematurely for a vote and the subsequent delay in momentum that typically results from this situation.

The Committee has been informed that CDFA is supervising the collection of test data at the state and local level. While the Committee acknowledges and is appreciative of the submission of data by the manufacturers, the Committee is interested in seeing the data collected by California and considering the results and potential impact relative to the proposed changes. The Committee maintains its position that the "informational" status of this item is appropriate.

In reviewing your letter and in discussing these issues, we identified the following points and questions on which we would appreciate your input. Your feedback will assist us in maintaining momentum on these issues and moving them forward for resolution:

1) When commercial water meters are tested by a weights and measures official for the purpose of type evaluation or sealing, meters are tested in accordance with NIST Handbook 44, and the official uses the readings from the registers attached to the meters. At this time, weights and measures officials are unclear about the methods used by meter manufacturers. If meters are tested to other standards using other test

methods, flow rates and tolerances, this could be a source of the variation seen between official test results and the manufacturers' data.

An additional point in this regard is the application of the tolerances outlined in Handbook 44 during testing by the manufacturer. The tolerances in Handbook 44 apply to a metering system, not the meter alone. That is, one must consider the contribution of errors from all sources in a system; for example, errors can be contributed from the register as well as the meter.

   a. Are manufacturers testing water meters in their facilities with the same indicators with which they will be used in the field?
   b. Is the test data provided thus far a reflection of meter performance alone or performance of the meter with the register that will be used in the final application?
   c. Are allowances made in performance levels to ensure that the addition of a register in the final application will enable continued compliance with established tolerances?

2) What controls does the manufacturer have over the selection of the meter register in a water metering system?
   a. Do manufacturers choose the register used on a water meter?
   b. Does the manufacturer provide the register chosen by the customer?
   c. Does the user choose and install the register in the final installation?

3) The S&T Committee seeks answers to the following questions about the test methods used by the five major meter manufacturers (Sensus Metering System, Badger Meter, Neptune Technology Group Inc, Elster AMCO Water, and Master Meter Inc). Responses may be submitted individually or collectively.

   Factory Testing of New Meters
   a. Are meters tested to the AWWA standards using AWWA test draft sizes, flow rates and tolerances?
   b. Describe the test equipment and test methods (automated electronic pulse test system; scales for gravimetric testing; design of any provers used in the testing such as neck width and compliance with NIST 105 Series; etc.).
   c. If flow rates and draft sizes are different than those prescribed by AWWA or NIST Handbook 44, what flow rate and size draft are used for each meter size?
   d. Are meters ever tested as they would be tested by a weights and measures official (Handbook 44) or used by a customer, with the registers attached? If yes, are the registers read manually? If no, please explain how the results are read and recorded.
   e. Describe the quality assurance program for registers, including testing.
   f. Who controls the register selection for meters (manufacturer, customer, other).
   g. Please explain why meter indicators (proving hands) do not often align properly.

   Testing of Failed Meters

   If a meter is retested by the manufacturer after being rejected by a weights and measures official, describe the test method including equipment used, what flow rates and draft sizes are used, whether the register is read manually, what tolerances are applied, etc.

In closing, we believe it is important for all interested stakeholders to have the benefit of your thoughts on these issues so that they are able to fully consider all points of view. With your permission, we will forward your letter to the S&T Committee Chairmen at the Central and Northeast Weights and Measures Associations so that they may fully consider your comments in their deliberations on the relevant S&T Agenda Items. Additionally, we will take these comments under consideration in our future discussions on these issues and continue to study your points while we look forward to the additional data collection by CDFA.

Thank you in advance for your input on the points raised in this letter. If you have questions about any of these points or our comments, please feel free to contact us.

Sincerely,

Todd Lucas
Ohio Weights and Measures
Chairman, NCWM S&T Committee

Ed Williams
Director, California DFA Division of
Measurement Standards (CDFA)

CC: NCWM S&T Committee:
Brett Saum, San Luis Obispo County, California
Kristin Macey, California
Steve Giguere, Maine
Kenneth Ramsburg, Maryland
Ted Kingsbury, Measurement Canada, Technical Advisor
Steven Cook, NIST, Technical Advisor
Tina Butcher, NIST, Technical Advisor
Jack Kane, NCWM Chairman

From: Kristin Macey
Sent: Thursday, March 19, 2009 11:49 AM
To: Dan Reiswig; John Roach; Roger Macey
Cc: Ed Williams
Subject: Fw: Handbook 44, Section 3.36 Proposed Changes - Response to letter dated March 5, 2009

Importance: High

Attachments: NCWM ST Committee Response Letter 0319.pdf; HB 44 March 2009 Manu B Positive Displacement Data.pdf; HB 44 March 2009 Manu B Multi-Jet Data.pdf

Another meeting for next week?

From: Noel, Andre
To: lucas@agri.ohio.gov ; Ed Williams; Kristin Macey; tina.butcher@nist.gov
Cc: Roncoke@aol.com ; gdejarlais@badgermeter.com ; Scott.Swanson@Sensus.Com ; alex.watson@us.elster.com
Sent: Thu Mar 19 11:42:38 2009
Subject: Handbook 44, Section 3.36 Proposed Changes - Response to letter dated March 5, 2009

Dear Mr. Todd Lucas and Mr. Ed Williams.

In response to your March 5, 2009 letter, we respectfully submit to you the attached for your consideration and approval.

Please feel free to contact any of the undersigned should you have any questions.

We look forward to hearing from you.

Yours truly,

Scott Swanson - Sensus Metering System Tel: (724) 430-4059
George DeJarlais - Badger Meter, Inc Tel: (414) 371-5754
Andre Noel - Neptune Technology Group Inc Tel: (334) 283-7298
Alex Watson - Elster AMCO Water Tel: (352) 368-4652
Ron Koch - Master Meter, Inc Tel: (412) 847-2097

File Identification: HB 44 March 2009 Manu B Data

(Ref. 19 March 2009 Addendum C)

Handbook 44, Section 3.36 Water Meters -- Accuracy/Repeatability Testing at Various Test Drafts

Sheet 2: Testing of 5/8 x 3/4 Multi-jet Meters

-- fails to meet HB 44 requirements

-- only marginally passes HB 44 requirements

A. Testing with Gallon Registration

1. Tests at Intermediate Flow Rate of 2 GPM

	Accuracy, 40 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	100.60	100.71	100.88	100.73	0.28
G2	100.64	100.79	100.88	100.77	0.24
G3	100.17	100.42	100.43	100.34	0.26
G4	100.51	100.67	100.85	100.68	0.34
G5	100.83	101.03	101.08	100.98	0.25

	Accuracy, 20 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	100.88	100.67	100.66	100.74	0.22
G2	100.98	100.76	100.88	100.87	0.22
G3	100.25	100.41	100.25	100.30	0.16
G4	100.82	100.66	100.56	100.68	0.26
G5	100.98	100.95	100.91	100.95	0.07

	Accuracy, 10 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	101.17	100.30	101.05	100.84	0.87
G2	100.57	100.75	101.10	100.81	0.53
G3	100.60	100.05	100.55	100.40	0.55
G4	100.90	100.60	100.87	100.79	0.30
G5	101.17	100.75	101.10	101.01	0.42

A. Testing with Gallon Registration

2. Tests at Minimum Flow rate of 0.25 GPM

	Accuracy, 20 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	101.48	101.70	101.85	101.68	0.37
G2	98.32	98.50	98.85	98.56	0.53
G3	99.99	100.20	100.50	100.23	0.51
G4	102.82	102.60	103.00	102.81	0.40
G5	101.50	102.16	102.50	102.05	1.00

	Accuracy, 10 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	101.98	101.47	101.87	101.77	0.51
G2	98.32	98.35	98.40	98.36	0.08
G3	99.70	100.47	100.05	100.07	0.77
G4	102.48	102.67	103.05	102.73	0.57
G5	101.98	102.20	102.17	102.12	0.22

	Accuracy, 5 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	100.00	102.00	100.00	100.67	2.00
G2	99.40	97.20	99.40	98.67	2.20
G3	99.00	99.40	100.60	99.67	1.60
G4	103.00	102.00	103.40	102.80	1.40
G5	102.80	102.00	103.20	102.67	1.20

B. Testing with Cubic Foot Registration

1. Tests at Intermediate Flow Rate of 2 GPM

	Accuracy, 4 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	99.93	100.08	99.93	99.98	0.15
F2	100.58	100.50	100.50	100.53	0.08
F3	99.40	99.35	99.33	99.36	0.07
F4	101.25	101.33	101.30	101.29	0.08
F5	100.35	100.33	100.43	100.37	0.10

	Accuracy, 2 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	99.65	100.20	100.00	99.95	0.55
F2	100.60	100.75	100.50	100.62	0.25
F3	99.15	99.50	99.35	99.33	0.35
F4	101.25	101.35	101.15	101.25	0.20
F5	100.30	100.50	100.35	100.38	0.20

	Accuracy, 1 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	99.80	100.20	99.60	99.87	0.60
F2	100.50	100.80	100.20	100.50	0.60
F3	99.30	100.00	98.70	99.33	1.30
F4	101.50	101.00	101.50	101.33	0.50
F5	100.30	100.00	100.70	100.33	0.70

2. Tests at Minimum Flow rate of 0.25 GPM

	Accuracy, 2 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	100.30	100.00	100.41	100.24	0.41
F2	98.15	98.70	99.22	98.69	1.07
F3	99.25	98.90	99.60	99.25	0.70
F4	101.75	101.25	101.63	101.54	0.50
F5	101.90	101.50	102.00	101.80	0.50

	Accuracy, 1 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	100.30	100.50	99.80	100.20	0.70
F2	99.00	98.30	98.70	98.67	0.70
F3	99.00	99.70	99.30	99.33	0.70
F4	101.70	101.30	101.70	101.57	0.40
F5	102.30	101.40	102.60	102.10	1.20

	Accuracy, .5 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	101.40	100.60	102.00	101.33	1.40
F2	98.60	99.40	100.60	99.53	2.00
F3	99.00	98.40	100.00	99.13	1.60
F4	102.00	101.00	103.60	102.20	2.60
F5	102.80	102.00	104.00	102.93	2.00

File Identification: HB 44 March 2009 Manu B Data

(Ref. 19 March 2009 Addendum C)

-- fails to meet HB 44 requirements

-- only marginally passes HB 44 requirements

Handbook 44, Section 3.36 Water Meters -- Accuracy/Repeatability Testing at Various Test Drafts

Sheet 1: Testing of 5/8 x 3/4 Positive Displacement Meters

A. Testing with Gallon Registration

1. Tests at Intermediate Flow Rate of 2 GPM

	Accuracy, 40 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	100.50	100.58	100.55	100.54	0.08
G2	100.25	100.30	100.25	100.27	0.05
G3	100.45	100.55	100.45	100.48	0.10
G4	100.00	100.00	100.00	100.00	0.00
G5	100.33	100.43	100.25	100.34	0.18

	Accuracy, 20 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	100.40	100.35	100.50	100.42	0.15
G2	100.25	100.15	100.20	100.20	0.10
G3	100.50	100.35	100.50	100.45	0.15
G4	100.00	100.00	100.00	100.00	0.00
G5	100.15	100.20	100.40	100.25	0.25

	Accuracy, 10 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	101.00	100.30	100.70	100.67	0.70
G2	100.30	100.30	100.00	100.20	0.30
G3	100.30	100.40	100.30	100.33	0.10
G4	99.70	100.00	100.00	99.90	0.30
G5	100.50	100.30	100.70	100.50	0.40

A. Testing with Gallon Registration

2. Tests at Minimum Flow rate of 0.25 GPM

	Accuracy, 20 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	97.85	98.15	97.90	97.97	0.30
G2	98.00	98.00	98.15	98.05	0.15
G3	96.65	96.70	96.90	96.75	0.25
G4	97.15	97.35	97.10	97.20	0.25
G5	97.65	97.85	98.00	97.83	0.35

	Accuracy, 10 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	98.00	97.70	97.80	97.83	0.30
G2	98.30	98.70	97.00	98.00	1.70
G3	96.80	96.50	96.30	96.53	0.50
G4	97.20	96.80	97.20	97.07	0.40
G5	97.70	97.70	97.60	97.67	0.10

	Accuracy, 5 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	97.00	98.60	98.00	97.87	1.60
G2	96.60	98.70	97.00	97.43	2.10
G3	96.00	97.40	96.00	96.47	1.40
G4	96.00	97.80	96.00	96.60	1.80
G5	96.80	98.00	97.20	97.33	1.20

B. Testing with Cubic Foot Registration

1. Tests at Intermediate Flow Rate of 2 GPM

	Accuracy, 4 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	99.78	99.64	99.63	99.68	0.15
F2	100.40	100.22	100.28	100.30	0.18
F3	100.27	100.19	100.19	100.22	0.08
F4	100.10	100.06	100.03	100.06	0.07
F5	100.65	100.47	100.73	100.62	0.26

	Accuracy, 2 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	99.30	99.85	99.50	99.55	0.55
F2	100.05	100.50	100.08	100.21	0.45
F3	99.94	100.50	99.93	100.12	0.57
F4	99.87	100.30	99.93	100.03	0.43
F5	100.52	100.50	100.60	100.54	0.10

	Accuracy, 1 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	99.53	99.37	99.13	99.34	0.40
F2	100.40	100.07	99.77	100.08	0.63
F3	100.20	100.07	99.95	100.07	0.25
F4	100.03	99.55	99.75	99.78	0.48
F5	100.90	100.43	100.10	100.48	0.80

2. Tests at Minimum Flow rate of 0.25 GPM

	Accuracy, 2 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	97.65	97.50	97.30	97.48	0.35
F2	96.70	96.75	96.15	96.53	0.60
F3	98.25	98.50	98.15	98.30	0.35
F4	97.90	97.85	98.15	97.97	0.30
F5	98.15	97.80	98.20	98.05	0.40

	Accuracy, 1 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	97.00	97.20	97.20	97.13	0.20
F2	95.70	96.30	96.00	96.00	0.60
F3	98.30	97.70	98.30	98.10	0.60
F4	98.00	97.70	97.70	97.80	0.30
F5	98.00	98.30	98.30	98.20	0.30

	Accuracy, .5 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	98.00	96.60	98.00	97.53	1.40
F2	96.60	94.80	98.00	96.47	3.20
F3	97.40	98.60	99.40	98.47	2.00
F4	96.60	99.00	97.60	97.73	2.40
F5	97.60	99.00	97.40	98.00	1.60

Date: 19 March, 2009

To: Todd Lucas, Chair, NCWM S&T Committee, and Ed Williams, Director, California DFA, Division of Measurement Standards)

CC: Tina Butcher (NIST) and Kristin Macey (CDFA)

From: Joint Letter from Five Water Meter Manufacturers

Subject: Handbook 44, Section 3.36 Proposed Changes

Re: Response to Your Letter of March 5, 2009

Dear Todd and Ed:

The five water meter manufacturers received your letter dated March 5, 2009.

We look forward to receiving your response to the five (5) points raised in our February 12th letter. Again, in not supporting the compromise proposal from the afternoon of January 13th, we believe that actions taken by California DMS will effectively continue the restriction of trade in the submetering market for water meter manufacturers, including any new submission of meters for CTEP approval.

We are providing ***Addendum A*** to address potential confusion over specific details, regarding the January 13th compromise proposal.

In ***Addendum B*** to this letter, we have attempted to address your request for "additional feedback on some additional points" regarding manufacturers' test practices. While such information may be of interest to the NCWM, please note that it adds no weight to the issues we have regarding current provisions of HB 44. With this in mind, please note that all of the manufacturer test data supplied to the S&T Committee in 2008, and now in 2009, have been generated using the same test methods that would be used by W&M jurisdictions, as during California TEP testing or during audit testing by county jurisdictions. Specifically, we have been manually reading the same mechanical registration devices that are used in field installations.

Under ***Addendum C*** to this letter, we are supplying additional manufacturer test data, similar to that provided in our February 23rd submittal to you. Furthermore we also look forward to your collecting and sharing of the additional data under the supervision of CDFA. We believe that data generated at the Sacramento DMS test benches, when using the test format we have established, will clearly identify the areas of concern, and hopefully allow us to work together on lifting the existing market barriers.

As you well know, our foremost concern is that water meter manufacturers today are effectively prohibited from fully participating in the submetering market and from submitting meters for CTEP approval. As members of the NCWM we are not aware of one instance, when the conference knowingly placed a barrier to an industry from participating and obtaining approvals from within their own code of the Handbook. Yet this is what we have today, particularly in the recently-added provisions for repeatability testing. We can only hope that our data, coupled with the timely receipt of data from CDFA will raise the awareness of this issue and allow you to provide us with recommendations on how we can resolve this situation by the annual meeting in July 2009.

We welcome your suggestion that our February 12th letter be forwarded to the CWMA and the NEWMA S&T committees, if these regional committees are in a position to then act to place the our proposals as a voting item at the July 2009 national meeting. However, we believe that without prior participation and buy-in by the interested California parties, it may be difficult for these two regional groups to so act, as we do not believe that any of their members have any experience or potential interests in testing utility-type water meters.

As the logical next step, we are very interested in meeting with you and all interested Californian parties (either in California or at a more central location) to discuss this further, with the goal of reaching a resolution, and setting a clear path to move these items forward in 2009.

We hope to hear from you by March 30, 2009, in order to best use what little time is left to us in advance of the July 2009 annual meeting.

Yours truly,

Scott Swanson - Sensus Metering System	Tel: (724) 430-4059
George DeJarlais - Badger Meter, Inc	Tel: (414) 371-5754
Andre Noel - Neptune Technology Group Inc	Tel: (334) 283-7298
Alex Watson - Elster AMCO Water	Tel: (352) 368-4652
Ron Koch - Master Meter, Inc	Tel: (412) 847-2097

Attachments: Addendum A, B, and C (Addendum C includes separate Excel Spreadsheets)

ADDENDUM A

COMMENTS - JANUARY 2009 INTERIM MEETING NCWM AGENDA ITEMS

From your 5 March response, we believe that there may be some uncertainty over the actual content of the PM 13 January compromise proposal. With the AM 13 January rejection of our original repeatability proposal (subsequently documented as "336-2 W T.1.1. Repeatability"), it was noted that revival of (what was subsequently documented as) "336-3 I N.3. Test Drafts and N.4. Testing ……..etc." would at least partially address some of these same repeatability concerns, (while harmonizing with AWWA low flow test drafts and fully addressing our accuracy test concerns, as supported by the data supplied by the manufacturers in response to the WWMA meeting last September). To further address these repeatability concerns, we then suggested that the "336-3" intermediate rate test draft proposed sizes be doubled (to 20 gallons/2 cubic feet for utility meters 1" and smaller, and to 200 gallons/20 cubic feet for larger utility meters). In this way, we would accede (at least on an interim basis) to the AM 13 January contention that accuracy testing and repeatability testing use the same test draft sizes. These proposed intermediate rate draft sizes are indeed larger than those given in AWWA M6, but please note that:

1. AWWA test requirements <u>do not include tolerances for repeatability</u>.

2. The HB tolerance ranges for repeatability <u>are tighter than the AWWA (or the HB 44) tolerance ranges for accuracy (by a factor of 5 to 1), and so cannot tolerate the same levels of test uncertainties from limitations in meter reading resolution</u>.

3. The PM 13 January proposed intermediate rate test drafts <u>do not result in a significant increase in test times</u> (for example, in going from the current 1 cubic foot test draft for 5/8" meters to the proposed 2 cubic foot draft, the 2 gpm test time increases by less than 4 minutes).

We understand your concern that support for any proposed changes is problematic, unless there are open hearings and "deliberations at the national, state, and regional level". Please understand our concern, however, in that these meter reading resolution and test uncertainty issues have already been presented to all four regional S&T groups last September and October, and, other than the WWMA request for additional test data (subsequently provided in late-2008 by all five manufacturers, although similar data from California jurisdictions is still lacking), our discussions <u>did not generate any feedback</u>.

ADDENDUM B

MANUFACTURERS TEST PRACTICES

NOTE: While the factory testing of new and failed meters is of interest to the NCWM, please note that this is not directly related to 'manual' testing performed by W&M officials under the requirements of Handbook 44.

Methods and practices used during production tests of water meters (i.e., "initial verification" testing) can differ greatly from those used in such 'manual' tests, of course. This is an economic necessity, given the fact that we are producing over 5 million utility-type water meters each year. Test times (and costs) can be minimized through the use of improved meter reading resolution, along with other methods that reduce the total test uncertainty. The manufacturers discussed this at some length with the California DMS and county jurisdictions, during our April 2008 meeting in Sacramento. We stress that our quality control measures (including the controls on total production test errors) enforce compliance with all accuracy requirements (including those given under HB 44 and by the applicable AWWA standards). Specific examples of production test methods (and testing of meters returned after rejection by W&M officials) are given below. Please note that test methods can vary from one manufacturer to the next or even from one test stand to the next within a single manufacturer's facilities.

FACTORY TESTING OF NEW METERS

Production test stands consist of five fully automated systems and one partially automated gravimetric test stand that are generally considered to be accurate to better than ± 0.1% precision as compared to typical purchased benches that are only capable to ± 0.25% if properly maintained and calibrated on at least an annual basis as strongly recommended by the test stand manufacturer. AWWA Manual M6 only requires test stands to be capable of ± 0.3 %. While typical purchased volumetric test stands can be bought for $ 3,000 or less, automated production test stand systems represent an investment between $125,000 and $150,000 each depending on the year built. These five automated production test stands have the capacity for annual volumes of between 1 and 1 ½ million meters per year.

Presently, these automated test systems test the entire meter and register as a unit. The type register selected for the meter is as prescribed by the end customer. Register data collection is accomplished by using a focused infra-red light source precisely mounted on test heads that fit over the twenty meters to be tested in each test system. Reflected light from the chromed flow finder indicator is counted by an integral computer system in the test system; no human interpolation is involved. Note that the red, spur-gear-driven sweep hand with its attendant backlash that is problematic for some weights and measures officials is not used in these automated test facilities. Test water is weighed by very high precision weigh scales that are also temperature corrected to yield test draft quantity. The actual test flow rate is calculated by the on-board computer, however during the test, three integral magnetic flowmeters monitor and automatically provide very slight flow rate adjustments to maintain the flow rate to within ± 1% although rate standards prescribe only ± 5% for the Qmin, Qt and Qn test flow rates.

Draft sizes are modified according to meter size so that a minimum of 2,000 pulses at low flows to more than 4,000 light pulses at Qn flows are counted by the data collection devices. This assures that the precision of this component of the test is ± 1/2000 (or ± 0.05%) at the low flows and ± 1/4000 (± 0.025%) at Qn flow rates, and is accomplished without parallax or interpretation.

The integral computer performs the data reduction function; results are both displayed for the operator, sent to the test tag printer and sent to the factory's main computer for storage and retrieval purposes as needed. Again, human error in data transfer or reduction isn't involved.

ADDENDUM B

FACTORY TESTING OF NEW METERS - continued

In addition to regular re-calibration, production test systems are regularly compared to the modified manual benches used by the Quality Department and Repair Department test benches. These two benches are both specially modified 10-place test stands that have converted volumetric tanks as weigh vessels. Meter registers are read manually; other features are similar to the production benches in that test drafts are normally weighed with temperature correction using high precision scales and flow rate is monitored by magnetic meters; the operator makes small rate adjustments manually if needed. Data reduction and recording are done manually but the reduced data is presented following significant digit format.

In addition to these **"Round Robin"** internal test accuracy comparisons, a manufacturer regularly compares meters tested by similar high precision systems at a sister division, compares to water utility acceptance tests and also compares with test data from an independent gravimetric system located at a Water Lab. The "Round Robin" technique is a quality control method that has been employed by both fluid meter manufacturers and national metrology labs (such as NIST) for more than 30 years (when NIST operated doing business as NBS).

MANUFACTURER's TESTING OF FAILED METERS

When a water meter is returned after being rejected by a Weights and Measures official, that meter(s) is tested as-received on the gravimetric test bench in the Repair Department. Test technicians conducting these tests have between five and thirty years of experience in testing water meters.

As described previously, the test bench used is a gravimetric one using a high precision scale where that scale provides at least ± 0.10% precision on the draft measurement. For small residential meters, the draft size is recorded as the weight equivalent of nominally 10 gallons (about 85#) at the low flow, 10 gallons at the Qt flow and 100 gallons (about 850#) at Qn or these are the three test flow rates prescribed by AWWA Manual M6. The exact draft volume used in the data reduction calculations is corrected for the over / under the nominal value. The tester is trained to maintain the desired flow rate by making small adjustments if the rate as displayed by the appropriate magnetic flowmeter (again there are 3 magnetic flowmeters used, matched to the flow rate) makes small deviations from the desired rate during the test.

The register sweep hand and mechanical odometer are read manually; these testers are trained to use proper techniques to allow for consistent handling of possible parallax and inter-mark interpretation. The AWWA Manual M6 meter tolerances are those used for New Meter accuracy % registration at the three test flows; these results are not presented in the % error format to be consistent with AWWA water industry practice. As stated, retest data is presented using significant digit format, or the % registration is reported as 100.2% or 99.6% as examples.

ADDENDUM C

MANUFACTURER B TEST DATA

In further support of our of our 12 February letter to you, please find attached an Excel spreadsheet labeled as a reference for this Addendum C. As discussed with Kristin Macey on 14 January, the manufacturers continue to perform additional testing, expanding upon the test data that was provided to the National S&T Committee prior to the January interim meeting. At this time, a second manufacturer's testing has progressed to the point that the full test format has been completed, for groups of both 5/8 x ¾ positive displacement meters and 5/8 x ¾ multi-jet meters, covering both gallon and cubic feet registration. As with all other test data previously submitted to the S&T Committee, these results were generated by manually reading the same mechanical registration devices that are used in field installations.

Observations and comments on this latest data:

1—**5 Gallon (or 0.5 Cubic Foot) Drafts at 0.25 GPM:** The minimum flow rate test with a 0.5 cubic foot draft uses only half of the current HB 44 draft. This was performed in conjunction with the analogous minimum flow rate test with a 5 gallon draft (which **is** the current HB 44 draft size). Both drafts result in only ½ revolution of the typical proving indicator (i.e., providing only 50 graduations for indicated through-put), causing unacceptable test uncertainties and unreliable results:

a—Ten of ten PD meters fail to meet the HB 44 range for repeatability. Nine of ten MJ meters fail to meet the HB 44 repeatability range requirement.

b—Four of 30 individual accuracy tests for MJ meters fail to meet the HB 44 limits of + / - 3.0%, with an additional three individual MJ accuracy tests that only marginally meet the HB 44 limits.

When the 0.25 gpm test drafts are increased to 10 gallons or 1 cubic feet**, (the compromise position discussed on the afternoon of 13 January**) there is only one failure for repeatability (PD unit G2), and only one individual accuracy test failure (for MJ unit G4). For individual meters, there are also some significant changes (of roughly 1%) in the three-test average accuracy results. This clearly shows the inadequacies when only ½ revolution, rather than one full revolution, of the proving indicator is used.

When the 0.25 gpm test drafts are further increased to 20 gallons or 2 cubic feet, there are no significant changes, aside from elimination of the two isolated accuracy and repeatability failures seen at 10 gallons/1 cubic foot.

2—10 Gallon or 1 Cubic Foot Drafts at 2.0 GPM: The intermediate flow rate tests with 10 gallon or 1 cubic foot drafts are the current HB 44 requirements. Both drafts result in only one revolution of the typical proving indicator (i.e., providing only 100 graduations for indicated through-put). Since the tolerance ranges at intermediate flow are half as large as those for the minimum flow rate tests, these intermediate rate draft sizes also cause unacceptable test uncertainties and unreliable results:

a— Thee of ten PD meters, and three of ten MJ meters fail to meet the HB 44 range of 0.6% for repeatability.

b—Two of 30 individual accuracy tests (both for MJ unit F4) only marginally meet the HB 44 limits of + 1.5% / - 1.5%.

ADDENDUM C

MANUFACTURER B TEST DATA - continued

When the 2 gpm test drafts are increased to 20 gallons or 2 cubic feet **(the compromise position discussed on the afternoon of 13 January)**, there are no longer any 'marginal' accuracy results, and only three meters (MJ unit F1 and PD units F1 and F3) have 'marginally-passing' repeatability results. For some individual meters, there are only moderate changes (typically at 0.2% or less) in the three-test average accuracy results.

When the 2 gpm test drafts are increased to 40 gallons or 4 cubic feet (our original September 2008 proposal for repeatability testing only), even the 'marginally-passing' results have been eliminated. Only minor changes are seen in the three-test average accuracies for individual meters

Again, while this new 2009 test data is somewhat more extensive, it is entirely consistent with 2008 data supplied to the committee by the individual water meter manufacturers. We have seen no conflicting test data showing that current test drafts do not result in unacceptable meter reading uncertainties, and feel confident that if the California DMS test facility was used to perform the same test program that is detailed on our attached Addendum, similar results would be generated.

Attachment: Addendum C – (Excel Files: HB 44 March 2009 Manu B Positive Displacement and HB 44 March 2009 Manu B Multi-Jet Data)

From: Noel, Andre [anoel@neptunetg.com]
Sent: Tuesday, May 05, 2009 8:09 AM
To: lucas@agri.ohio.gov; Ed Williams; tina.butcher@nist.gov; Kristin Macey
Cc: bsaum@co.slo.ca.us; Roncoke@aol.com; gdejarlais@badgermeter.com; alex.watson@us.elster.com; Scott.Swanson@Sensus.Com
Subject: Handbook 44, Section 3.36 Proposed Changes - Additional Support (Manufacturer E)

Attachments: NCWM ST Committee Man E Data 0509.pdf; HB 44 April 2009 Manu E Data.pdf

Dear Mr. Todd Lucas and Mr. Ed Williams.

We respectfully submit to you additional test data to support our letter dated March 19, 2009 for your consideration and approval.

Please feel free to contact any of the undersigned should you have any questions.

We look forward to hearing from you.

Yours truly,

Scott Swanson - Sensus Metering System	Tel: (724) 430-4059
George DeJarlais - Badger Meter, Inc	Tel: (414) 371-5754
Andre Noel - Neptune Technology Group Inc	Tel: (334) 283-7298
Alex Watson - Elster AMCO Water	Tel: (352) 368-4652
Ron Koch - Master Meter, Inc	Tel: (412) 847-2097

File Identification: HB 44 April 2009 Manu E Data

1 May 2009 additional data

-- fails to meet HB 44 requirements (red)

-- only marginally passes HB 44 requirements (yellow)

Handbook 44, Section 3.36 Water Meters -- Accuracy/Repeatability Testing at Various Test Drafts

Sheet 1: Testing of 5/8 x 3/4 Positive Displacement Meters

A. Testing with Gallon Registration

1. Tests at Intermediate Flow Rate of 2 GPM

	Accuracy, 40 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	100.86	100.71	100.71	100.76	0.15
G2	100.79	100.54	100.51	100.61	0.27
G3	100.61	100.46	100.69	100.59	0.22
G4	100.21	100.26	100.36	100.28	0.15
G5	101.19	100.69	101.06	100.98	0.50

	Accuracy, 20 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	100.82	100.90	100.67	100.80	0.23
G2	100.92	100.85	100.42	100.73	0.50
G3	100.57	100.40	100.47	100.48	0.17
G4	100.12	100.15	100.37	100.22	0.25
G5	101.17	100.95	100.77	100.97	0.40

	Accuracy, 10 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	100.50	100.95	100.70	100.72	0.45
G2	100.20	101.45	99.50	100.38	1.95
G3	100.40	100.55	100.90	100.62	0.50
G4	100.60	99.55	101.20	100.45	1.65
G5	100.40	101.95	100.20	100.85	1.75

2. Tests at Minimum Flow rate of 0.25 GPM

	Accuracy, 20 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	97.17	97.67	98.37	97.74	1.20
G2	98.22	98.47	99.12	98.61	0.90
G3	98.87	99.52	99.62	99.34	0.75
G4	97.52	98.42	98.42	98.12	0.90
G5	99.37	100.03	100.33	99.91	0.95

	Accuracy, 10 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	96.80	97.90	98.30	97.66	1.50
G2	97.10	99.20	98.60	98.30	2.10
G3	98.70	98.90	100.10	99.23	1.40
G4	98.00	97.10	98.10	97.73	1.00
G5	98.70	100.80	100.20	99.90	2.10

	Accuracy, 5 gallon draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
G1	97.20	98.50	98.80	98.17	1.60
G2	98.00	98.70	100.00	98.90	2.00
G3	98.80	99.50	99.60	99.30	0.80
G4	99.00	98.10	97.19	98.10	1.81
G5	100.20	99.90	102.81	100.97	2.91

B. Testing with Cubic Foot Registration

1. Tests at Intermediate Flow Rate of 2 GPM

	Accuracy, 4 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	100.82	101.13	100.78	100.91	0.35
F2	100.77	100.90	100.80	100.82	0.13
F3	100.60	100.90	100.53	100.67	0.38
F4	100.82	100.80	100.83	100.82	0.03
F5	101.10	100.85	100.80	100.92	0.30

	Accuracy, 2 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	101.20	101.00	100.75	100.98	0.45
F2	100.75	101.10	100.70	100.85	0.40
F3	101.05	100.70	100.60	100.78	0.45
F4	100.90	100.65	100.85	100.80	0.25
F5	101.00	100.55	100.60	100.72	0.45

	Accuracy, 1 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	100.05	101.50	100.70	100.75	1.45
F2	100.85	101.20	100.70	100.92	0.50
F3	99.95	101.60	100.40	100.65	1.65
F4	100.85	100.80	101.20	100.95	0.40
F5	100.95	100.30	102.20	101.15	1.90

2. Tests at Minimum Flow rate of 0.25 GPM

	Accuracy, 2 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	99.14	98.80	99.10	99.01	0.34
F2	98.44	98.55	98.15	98.38	0.40
F3	96.72	96.99	96.55	96.75	0.45
F4	98.54	99.45	99.20	99.06	0.91
F5	97.93	98.80	98.50	98.41	0.87

	Accuracy, 1 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	97.80	99.90	98.50	98.73	2.10
F2	98.80	98.70	98.50	98.67	0.30
F3	95.90	98.00	96.80	96.90	2.10
F4	99.10	99.30	99.50	99.30	0.40
F5	98.10	98.60	99.70	98.80	1.60

	Accuracy, .5 cubic foot draft				
Meter ID	Run 1	Run 2	Run 3	avg	range
F1	98.37	100.81	97.49	98.89	3.32
F2	98.17	98.39	97.89	98.15	0.50
F3	97.56	98.59	95.88	97.34	2.71
F4	98.17	99.40	99.10	98.89	1.22
F5	96.95	98.99	98.89	98.28	2.04

Date: May 5, 2009

To: Todd Lucas, Chair, NCWM S&T Committee, and Ed Williams, Director, California DFA, Division of Measurement Standards

CC: Tina Butcher (NIST) and Kristin Macey (CDFA)

From: Joint Letter from Five Water Meter Manufacturers

Subject: Handbook 44, Section 3.36 Proposed Changes

Re: Additional Test Data Provided by the Manufacturers

Dear Todd and Ed:

In further support of our February 12, 2009 letter to you, please find attached an Excel spreadsheet generated by manufacturer "E". Similar to the data provided with our February 23, 2009 e-mail (from manufacturer "C"), and the data provided with our March 19, 2009 letter (from manufacturer "B"), this latest data for ten positive displacement meters also demonstrate our concerns for too-small test drafts. As with all the other test data previously submitted to the S&T Committee, both in 2008 and in 2009, these results were generated by manually reading the same mechanical registration devices that are used in field installations.

Observations and comments on this latest data:

1—**5 Gallon (or 0.5 Cubic Foot) Drafts at 0.25 GPM:** The minimum flow rate test with a 0.5 cubic foot draft uses only half of the current HB 44 draft. This was performed in conjunction with the analogous minimum flow rate test with a 5 gallon draft (which **is** the current HB 44 draft size). Both drafts result in only ½ revolution of the typical proving indicator (i.e., providing only 50 graduations for indicated through-put), causing unacceptable test uncertainties and unreliable results:

a—Seven of ten meters fail to meet the HB 44 range for repeatability.

b—One of 30 individual accuracy tests fails to meet the HB 44 accuracy limits (third run for unit G5).

When the 0.25 gpm test drafts are increased to 10 gallons or 1 cubic feet (the compromise position discussed on the afternoon of January 13, 2009), seven of ten meters still fail to meet the HB 44 range (although there is a slight improvement in the ten-meter average range). However, with this increased test draft size, there are no longer any individual test failures for accuracy.

When the 0.25 gpm test drafts are increased to 20 gallons or 2 cubic feet (our original September 2008 proposals for repeatability testing only), repeatability results improve greatly, and there are no failures.

2—**10 Gallon or 1 Cubic Foot Drafts at 2 GPM:** The intermediate flow rate test with 10 gallon or 1 cubic foot drafts are the current HB 44 requirements. Both drafts result in only one revolution of the typical proving indicator (i.e., providing only 100 graduations for indicated through-put).

Since the tolerance ranges at intermediate flow are half as large as those for the minimum flow test rates, these intermediate rate test drafts can also exhibit excessive test uncertainties:

a—Six of ten meters fail to meet the HB 44 range for repeatability.

b—Two of 30 individual accuracy tests fail to meet the HB 44 accuracy limits (second run for G5 and second run for F3).

When the 2 gpm test drafts are increased to 20 gallons or 2 cubic feet (the compromise position discussed on the afternoon of January 13, 2009), none of the meters fail for repeatability or for individual accuracy test results.

When the 2 gpm test drafts are increased to 40 gallons or 4 cubic feet (our original September 2008 proposal for repeatability testing only), repeatability ranges show further improvement.

These latest test results again demonstrate the unacceptable meter reading uncertainties imposed by too-small test drafts, and are consistent with all the previous test data that we have provided. We have yet to see **any** alternative test results that would, in contrast, demonstrate that the current HB 44 test drafts are sufficient.

Yours truly,

Scott Swanson - Sensus Metering System	Tel: (724) 430-4059
George DeJarlais - Badger Meter, Inc	Tel: (414) 371-5754
Andre Noel - Neptune Technology Group Inc	Tel: (334) 283-7298
Alex Watson - Elster AMCO Water	Tel: (352) 368-4652
Ron Koch - Master Meter, Inc	Tel: (412) 847-2097

Attachment: Manufacturer E Data (Excel Spreadsheet)

Minimum Test Quantity

“The minimum quantity of water that must pass through the meter to ensure that there is a high level of confidence that the results of the test are accurate”

Uncertainty of Measurement

- The uncertainty of this measurement, is influenced by a number of general factors:
  - Measurement uncertainty of the test standard or test equipment
  - Any variations between the volume seen by the meter and that seen by the test standard or test equipment
  - Testing process errors (stability metering conditions, meter cyclic effect, error of the measured metering conditions, etc…)
  - Resolution of the water meter’s indicating device

Minimum Test Quantity Calculations

- The combined measurement uncertainty of the first three factors (Uref) must be determined. Assume Uref= 0.125% for the following exercises.

- For testing of water meters, two readings are taken (start of test run and end of test run)

- the uncertainty due to the resolution of the indicating device (e) is based on a triangular distribution of ± e (Guide to Uncertainty of Measurement (GUM)).

  $U\ res = e / \sqrt{6} = .41e$

- $Ures\ (\%) = .41e * 100 / TQ$, (TQ is the test quantity)

Minimum Test Quantity Calculations (cont:)

- The uncertainty of the measured meter error (Umeter) is calculated using this formula:

  $(\text{Umeter error } \%)^2 = (\text{Ures } \%)^2 + (\text{Uref } \%)^2$

- OIML recommends the following ratio between the meter MPE (maximum permissible error) and the expanded meter error measurement uncertainty when (k) = 2:

  Type Approval: 5:1

  Initial Inspection and Re-verification: 3:1

- $2 * \text{Umeter error } (\%) \leq \text{MPE}/5$ (for Type Approval)

  $\text{Umeter error } (\%) = \text{MPE}/10$ (for Type Approval)

Minimum Test Quantity Calculations (cont:)

- With the equations shown, the minimum test quantity can be calculated using this formula:

- Type Approval

  - $Q\ min = 0.41\ e \div \sqrt{\ (\ (MPE/10)^{2} - (.125)^{2}\ )}$

- Initial Inspection and Re-verification

  - $Q\ min = 0.41\ e \div \sqrt{\ (\ (MPE/6)^{2} - (.125)^{2}\ )}$

Minimum Test Quantity

Example # 1

Meter Size = 5/8 inch
Meter Type = PD
Meter Resolution (e) = 0.1 US gal
Flow Rate = 15 US gpm
MPE = ± 1.5 %
K=2
Type Approval Testing: 5 to 1 Ratio
Assume Uref= 0.125%

$TQ\ min = 0.41\ e \div \sqrt{\ (\ (MPE/10)^2 - (.125)^2\ )}$

$TQ\ min = 0.41 \times 0.1 \div \sqrt{\ (\ (1.5/10)^2 - (.125)^2\ )}$

TQ min = 49.44 US gal

Minimum Test Quantity

Example # 2

Meter Size = 5/8 inch
Meter Type = PD
Meter Resolution (e) = 0.1 US gal
Flow Rate = 1/4 US gpm
MPE = +1.5, -5 %
K=2
Type Approval Testing: 5 to 1 Ratio
Assume Uref= 0.125%

$TQ\ min = 0.41\ e \div \sqrt{\ ((MPE/10)^2 - (.125)^2)}$

$TQ\ min = 0.41 \times 0.1 \div \sqrt{\ ((1.5/10)^2 - (.125)^2)}$

TQ min = 49.44 US gal

Note: The MPE used in calculation would be 1.5 %

Minimum Test Quantity

Example # 3

Meter Size = 5/8 inch
Meter Type = Multi-jet
Meter Resolution (e) = 0.1 US gal
Flow Rate = 15 US gpm
MPE = ± 1.5 %
K=2
Type Approval Testing: 5 to 1 Ratio
Assume Uref= 0.125%

$TQ\ min = 0.41\ e \div \sqrt{\left((MPE/10)^2 - (.125)^2 \right)}$

$TQ\ min = 0.41 \times 0.1 \div \sqrt{\left((1.5/10)^2 - (.125)^2 \right)}$

TQ min = 49.44 US gal

Minimum Test Quantity

Example # 4

Meter Size = 5/8 inch
Meter Type = Multi-jet
Meter Resolution (e) = 0.1 US gal
Flow Rate = 1/4 US gpm
MPE = ±3 %
K=2
Type Approval Testing: 5 to 1 Ratio
Assume Uref= 0.125%

TQ min = $0.41 e \div \sqrt{((MPE/10)^2 - (.125)^2)}$

TQ min = $0.41 \times 0.1 \div \sqrt{((3/10)^2 - (.125)^2)}$

TQ min = 15.03 US gal

Note: The MPE used in calculation would be 3 %

Minimum Test Quantity

Example # 5

Meter Size = 5/8 inch
Meter Type = PD
Meter Resolution (e) = 0.1 US gal
Flow Rate = 15 US gpm
MPE = ± 1.5 %
K=2
Initial Inspection: 3 to 1 Ratio
Assume Uref= 0.125%

$TQ\ min = 0.41\ e \div \sqrt{\left((MPE/6)^2 - (.125)^2 \right)}$

$TQ\ min = 0.41 \times 0.1 \div \sqrt{\left((1.5/6)^2 - (.125)^2 \right)}$

TQ min = 18.93 US gal

Minimum Test Quantity
Example # 6

Meter Size = 5/8 inch
Meter Type = PD
Meter Resolution (e) = 0.1 US gal
Flow Rate = 1/4 US gpm
MPE = +1.5, -5 %
K=2
Initial Inspection : 3 to 1 Ratio
Assume Uref= 0.125%

$TQ\ min = 0.41\ e \div \sqrt{\ (\ (MPE/10)^{2} - (.125)^{2}\ )}$

$TQ\ min = 0.41 \times 0.1 \div \sqrt{\ (\ (1.5/6)^{2} - (.125)^{2}\ )}$

TQ min = 18.93 US gal

Note: The MPE used in calculation would be 1.5 %

Minimum Test Quantity

Example # 7

Meter Size = 5/8 inch
Meter Type = Multi-jet
Meter Resolution (e) = 0.1 US gal
Flow Rate = 15 US gpm
MPE = ± 1.5 %
K=2
Initial Inspection : 3 to 1 Ratio
Assume Uref= 0.125%

$TQ\ min = 0.41\ e \div \sqrt{\left((MPE/10)^2 - (.125)^2 \right)}$

$TQ\ min = 0.41 \times 0.1 \div \sqrt{\left((1.5/6)^2 - (.125)^2 \right)}$

TQ min = 18.93 US gal

Minimum Test Quantity

Example # 8

Meter Size = 5/8 inch
Meter Type = Multi-jet
Meter Resolution (e) = 0.1 US gal
Flow Rate = 1/4 US gpm
MPE = ±3 %
K=2
Initial Inspection : 3 to 1 Ratio
Assume Uref= 0.125%

$$TQ\ min = 0.41\ e \div \sqrt{(\ (MPE/10)^2 - (.125)^2\ )}$$

$$TQ\ min = 0.41 \times 0.1 \div \sqrt{(\ (3/6)^2 - (.125)^2\ )}$$

TQ min = 8.47 US gal

Note: The MPE used in calculation would be 3 %

Minimum Test Quantity
Summary Table

Example	Meter Type	Inspection Type	Meter Resolution (US gal)	Flow Rate (US gpm)	MPE	K=	Uncertainty Ratio	TQ Min (US gal)
#1	PD	Type Approval	0.1	15	±1.5 %	2	5 : 1	49.44
# 2	PD	Type Approval	0.1	1/4	+1.5 % -5%	2	5 : 1	49.44
# 3	Multi-jet	Type Approval	0.1	15	± 1.5 %	2	5 : 1	49.44
# 4	Multi-jet	Type Approval	0.1	1/4	±3 %	2	5 : 1	15.03

Minimum Test Quantity
Summary Table

Example	Meter Type	Inspection Type	Meter Resolution (US gal)	Flow Rate (US gpm)	MPE	K=	Uncertainty Ratio	TQ Min (US gal)
#5	PD	Initial Verification	0.1	15	±1.5 %	2	3 : 1	18.93
#6	PD	Initial Verification	0.1	1/4	+1.5 % -5%	2	3 : 1	18.93
#7	Multi-jet	Initial Verification	0.1	15	± 1.5 %	2	3 : 1	18.93
#8	Multi-jet	Initial Verification	0.1	1/4	±3 %	2	3 : 1	8.97

From: Ted.Kingsbury@ic.gc.ca
Sent: Tuesday, March 03, 2009 11:56 AM
To: Lucas@agri.ohio.gov; tina.butcher@nist.gov
Cc: Ed Williams; Kristin Macey; bsaum@co.slo.ca.us; James.Welsh@ic.gc.ca; steve.giguere@maine.gov; RamsbuKR@mda.state.md.us; carol.hockert@nist.gov; steven.cook@nist.gov
Subject: RE: Water Meter Manufacturer's Letter

Attachments: minimum test quantities examplesrev1.ppt
Dear S&T Committee members,

I would like to take this opportunity to inform you that Measurement Canada has been contacted by the same group of water meter manufacturers who are seeking information about minimum test quantities (draft sizes) and our agency's position on how this is addressed in Section 3.36 of NIST Handbook 44. Measurement Canada has chosen not to comment directly on the information that is contained in Handbook 44; rather, we have informed the manufacturers of the method and procedures Measurement Canada will follow when determining the minimum test quantity for future water meter inspections (we are currently developing requirements for type approval and initial verification). These will be based on the principles set-out in the *OIML G 1-100 Edition 2008 (E) Evaluation of measurement data – Guide to the expression of uncertainty in measurements (GUM*).

Attached is a PowerPoint presentation demonstrating how Measurement Canada would calculate the minimum test quantity for different types of meters, flow rates and types of inspections.

Do not hesitate to contact me or Mr. James Welsh (James.Welsh@ic.gc.ca) who is leading the Measurement Canada water meter project if you have questions on this matter.

Best regards,

Ted Kingsbury

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From: Butcher, Tina G. [mailto:tina.butcher@nist.gov]
Sent: March 3, 2009 12:27 PM
To: Lucas, Todd
Cc: bsaum@co.slo.ca.us; KMacey@cdfa.ca.gov; RamsbuKR@mda.state.md.us; steve.giguere@maine.gov; Cook, Steven E.; Kingsbury, Ted: MC; Butcher, Tina G.; Ed Williams; Hockert, Carol
Subject: Water Meter Manufacturer's Letter

Hi Todd,

Per my discussion, since you were out yesterday and haven't had a chance to look over the draft letter to the water meter manufacturers, I've revised the letter to include the editorial comments I received thus far. This way you will have the benefit of other comments already incorporated. So that Ed and the S&T Committee are apprised of the these changes, I am copying everyone on my original distribution list.

For others' benefit, the most significant change is that I reversed the order of discussion on 336-2 and 336-3 to follow the order they appear in the Committee's report rather than the order they are referenced in the water meter manufacturer's letter. Also note that I've included a cc to Jack Kane since the issue has escalated and the manufacturers have expressed concerns; if you agree with this, I will also forward a copy of their original letter to Jack.

Hope you are soon feeling back to your old self!
Tina